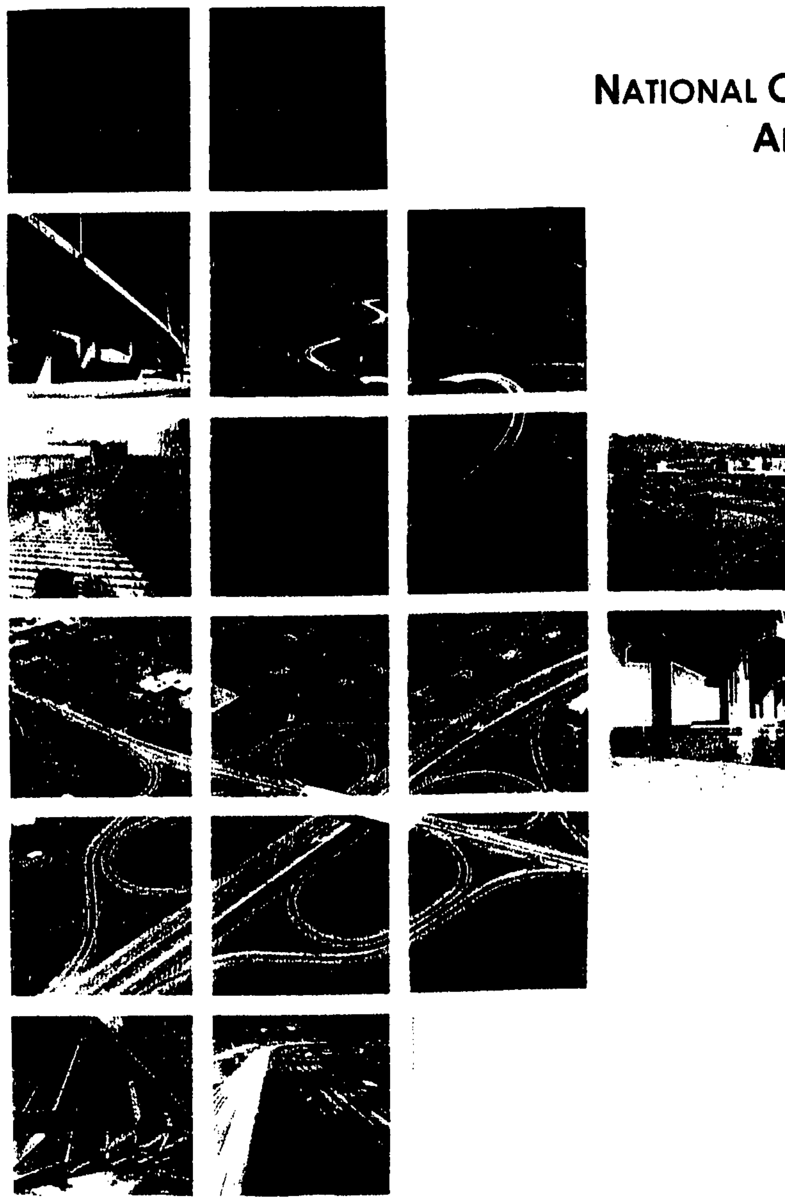
U.S. TRADE AND DEVELOPMENT AGENCY

SA-16, Room 309
Washington, DC 20523-1602
United States of America

PROGRAMA METRÓPOLIS

NATIONAL COMMISSION OF THE METROPOLITAN AREA OF BUENOS AIRES (CONAMBA)

MINISTERIO DEL INTERIOR



TRAFFIC MANAGEMENT SYSTEM

PHASE II
FINAL REPORT

Submitted by:

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The U.S. Trade and Development Agency

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TRAFFIC MANAGEMENT SYSTEM

PHASE II

TRAFFIC MANAGEMENT SYSTEM

Phase II Report

CONCEPTUAL SETTING

Conceptual Setting Of The Phase 2 Report

Scope of the Works Performed

The scope of Phase 2 of the Traffic Management Analysis for Buenos Aires developed for the Programa Metrópolis by the Consortium Louis Berger International, Inc. - IBI Group - UBATEC, comprises identification of the main arteries inside and outside of Buenos Aires Metropolitan Area where specific safety and traffic operation problems arise.

The report starts with the identification of the primary and secondary networks, and the review of present traffic operation along these routes based on field surveys conducted, on limited data field collection, and discussions with local traffic experts.

Phase 2 comprises the identification of the existing deficiencies in each of the selected routes, preparation of recommendation for each type of deficiency, development of solutions with the use of the Intelligent Transportation Systems (SIT) and definition of the systems to enforce traffic laws in order to relieve some of the traffic operative problems in the setting of a possible cost recuperation by the concessionaire.

Proposed Objectives

The Phase 2 first task was to identify the primary network. In the report corresponding to this Phase, a general description of the Buenos Aires Metropolitan Area urban structure and the placement of the Highway Network within the Area are developed. In addition, a synthetic description of the Primary Highway Network in the Area under study and a characterization of the arteries from the point of view of traffic volume and composition, is presented.

From this network, specific sections or segments for a more detailed survey were selected. The sections analyzed are:

- Route 1: Avenida 9 de Julio
- Route 2: Avenida Pueyrredón
- Route 3: Avenida Pavón / Av. Hipólito Yrigoyen
- Route 4: Provincial Route 202

Development of the Analysis

The preliminary character of Phase 2 report has to be reviewed within the context of the phases now in progress. As a short term application strategy, it is convenient to start implementing the group of proposed measures, the so called Intelligent Transportation Systems (ITS) through its application in high speed highways, a project already developed by the Consortium Louis Berger International, Inc. - IBI Group - UBATEC in the framework of Phase 1 of this Consulting Contract.

The extension of the intelligent transportation system to the rest of the Buenos Aires Metropolitan Area main highway network belongs to a second stage.

The works were performed based on the existing statistical data and in situ field surveys conducted by intervening professionals. The interaction of both methods allows the creation of a diagnosis matched to the needs of each of the links involved, and based on such diagnosis, the building of a scheme of progressive improvement aimed to increase the operational efficiency and safety of the mentioned ways.

The description of the preliminary analyzed four links allows a qualitative analysis of the highways network, due to the fact that their selection was made based on homogeneity criteria permitting the extrapolation to the rest of the networks of the conclusion derived form the study.

Therefore, each link can be characterized as follows:

- **Route 1 (Ave. 9 de Julio)**: two-way multilane urban avenue, selected because it presents the largest traffic management difficulties in view of the high vehicular congestion, and large pedestrian and vehicle volume crossing the Route.

- **Route 2 (Ave. Pueyrredón)**: one-way multilane urban avenue; typical avenue linking downtown with the city belt highway, showing radial and crosswise traffic superimposition, requiring therefore, a special treatment.

- **Route 3 (Ave. Pavón / Ave. Hipólito Yrigoyen)**: typical urban / suburban avenue where local and passing traffic are mixed.

- **Route 4 (Provincial Route 202)**: linking way of an urban core defined as satellite, with the transportation primary network (in this case the town of San Miguel with Acceso Norte, from which the Acceso Norte traffic is structured). Having surroundings with relatively low population density, it allows the adoption of solutions prioritizing the fast linkage of the main nodes.

Recommendations

The Consortium's expert team made a series of recommendations divided into two large groups.

First of all, solutions for the Traffic Operation and Safety were presented, made up by a set of recommendations based on engineering aspects for each identified deficiency in the selected routes. These recommendations are directed to alleviate the deficiencies in the whole route, but not to improve the traffic operation in a specific place.

The second group of recommendations were derived applying the Intelligent Traffic System procedures, and based on the results from the evaluations of needs, and the definition of problems appearing in the routes object of the study, opportunities were identified for the application of the ITS that potentially could be used to solve some of the problems. The opportunities identified for the application of the ITS in this initial stage offer an important functional description from the conceptual point of view.

Conclusions

The Phase 2 Report can be used as a preliminary tool for subsequent developments of individual executive projects for each link. Therefore it is necessary to progress in the political objectives in order to establish priorities to manage the traffic along main arteries. The links first analyzed develop both in the Ciudad Autónoma de Buenos Aires and the Province of Buenos Aires, crossing in both cases more than one administrative area of the so called Metropolitan Region. In this way, it is possible to commence the studies aimed to obtain a generalization of the intelligent transportation systems for the Metropolitan Region based on the items already analyzed.

1.- INTRODUCTION

The Buenos Aires Traffic Management Study comprises the identification of specific routes within the Metropolitan area and the expansion of the study to areas not identified as metropolitan but which can be considered a continuation of the urban networks presenting safety and operational problems, and in which a review of the existing traffic operation based on field surveys, and the limited data collection and discussions with local traffic experts, is needed. In addition, Phase 2 also includes identification of present deficiencies in each selected route; the preparation of recommendations for each type of identified deficiency; the development of TIS solutions, and definition of systems to enforce traffic laws in order to alleviate some of the operative traffic problems taking into consideration the cost recuperation by the concessionaires.

The appendix hereto comprises a first title with the general description of the Buenos Aires Metropolitan Area highway structure and the position of the Area Highway Network; a second title with the description of the Primary Highway Network in the Area under study, and finally a last title with the characterization of the routes from the point of view of traffic volume and composition.

For a more detailed survey, specific sections or segments were selected from this network.

1.1 Description of the Routes under the Study

Four (4) routes have been identified for Phase 2 of this study. Two (2) of these four routes are arteries supporting an elevated traffic volume in the Federal Capital, the third one, is an important artery linking the Federal Capital and the Province of Buenos Aires, and the fourth one is a rural road outside the jurisdiction of the City of Buenos Aires. A summary of each route is detailed as follows:

Route : Ave. 9 de Julio

Avenue 9 de Julio is an important north-south artery in the center of the City of Buenos Aires, and is part of the road system of such center area. The area under study for the identified route is approximately 2.9 km long extending from Ave. Santa Fe in the north to Ave. San Juan in the south, This section has 24 signaled intersections very close together at approximately a distance of 100 meters between them.

Ave. 9 de Julio carries the larger traffic volume in the southern direction and traffic volumes south of Ave. Corrientes are higher than those north of Ave. Corrientes. In accordance with the information provided by officers of the Federal Capital Administration, the average annual daily traffic (AADT) between Ave. Santa Fe and Ave. Corrientes is 65,000 southbound vehicles per day (vpd) and 40,000 vpd northbound, while the AADT between Aves. Corrientes and Belgrano is 45,000 southbound and 40,000 northbound.

Route 2: Ave Pueyrredón

Ave. Pueyrredón is an one-way southbound artery. The area under study runs from Ave. Las Heras in the north end up to Ave. Rivadavia in the south end. This segment measures approximately 2.7 km with a total of 22 signaled intersections. The AATD is 40,000 vpd.

Route 3: Ave. Pavón / Ave. Hipólito Yrigoyen

Ave. Pavón is a north-south urban artery linking the Federal Capital east with Avellaneda, Province of Buenos Aires, extending south up to the city of Lanús, Province of Buenos Aires. Upon entering Lanús, Ave. Pavón changes its name to Ave. Hipólito Yrigoyen. The area under study runs from Ave. Bmé Mitre in the Buenos Aires north end / boundary with the city of Avellaneda up to Ave. San Martín in the south end. The length of the segment under study is approximately 4.0 km with a total of 18 signaled intersections. Distance between intersections varies between 100 and 300 meters. The AADT is 40,000 vpd along the whole section.

Route 4: Provincial Route 202

Route 202 is a two lane north-south rural road without separation island running from San Fernando, Province of Buenos Aires in the north up to Mariano Moreno, Province of Buenos Aires, in the south. The selected area of study is approximately 5.9 km long from the railroad bridge Malvinas in the south up to Ave. Gral. Juan Perón in the north. This segment has a total of eight signaled intersections close to each other, and one in the north. The AADT along the route is 22,400 vpd, 20% of which is made up of buses and trucks.

1.2 Methodology

The proposed Phase 2 methodology has been developed by our Project Team and UBATEC staff during the meetings held on July 29 and September 1, 1997. The proposed methodology focuses on the identification of the existing deficiencies in the specific routes under study and the development of recommendations to improve the traffic operation and safety.

For each route under study, the identification of the existing deficiencies in the specific routes was based totally on field investigations conducted in the selected highway sections and intersections. Data for intermediate points was collected (between signaled intersections) including number of lanes, street parking, travel restrictions, location of sidewalks and pedestrian crossing, and adjacent property between each signaled pair. On the other side, the status and operation of each existing signaled intersection was evaluated. In addition, a qualitative evaluation for the whole route was conducted in reference to commercial traffic including buses and trucks, and in reference to the pavement marking, its age, and pavement condition along the whole segment. A study of the travel time and delay for each specific route was conducted. This study did not conducted any traffic or turn census. Local agencies did not provide information on traffic data including accident statistics or traffic volumes in specific places along the routes. Therefore, the identification of the existing deficiencies was more or less qualitative due to the fact that no quantitative analysis was available (except for the travel time and delay study).

A set of recommendations based on engineering aspects was developed for each one of the deficiencies identified along each route. Recommendations include measures such as turn restrictions, traffic light phases, improvement in traffic light sequence, better road marking and signaling, and potential improvements in capacity. Due to the lack of quantitative analyses in specific places, the recommendations refer only to a particular type of identified deficiency, and are not aimed to improve the traffic operation in a particular spot.

Likewise, recommendations were made based on traffic management strategies with transportation intelligent systems, and Violation Enforcement Systems (VES) were implemented for the routes.

2.- EXISTING CONDITIONS AND DEFICIENCIES

2.1 *Route 1: Avenida 9 de Julio*

2.1.1 Inventory and Field Data

Avenue 9 de Julio is a two-way urban artery with separation of traffic flows, and a service road on each side. The number of main lanes varies between five (5) and eight (8) for each direction. The number of lanes in the northbound service road (Carlos Pellegrini) and the southbound service road (Cerrito) varies between two (2) and three (3). In the northern direction between Ave. Santa Fe and Ave. Córdoba, the northbound and southbound lanes are separated by an elevated brick median. Between Ave. Córdoba and Ave. Belgrano painted traffic islands and the elevated brick median acting as center division continues to the north towards Ave. Belgrano. The main line and the service road are separated by brick islands with grass in the center. This brick separation is also used as pedestrian walks. The separation vanishes near Ave. Corrientes where the main line main lanes and the three service road lanes in each direction merge into nine (9) northbound and southbound main lanes, surrounding the Obelisk monument and making up a kind of traffic circle. Every 100 meters approximately, crossing streets intersect the main and service roads in a single direction (eastbound or westbound) to make a deployment of signaled intersections at close distance between them. Figures 1A and 1B show the lane configuration along the Ave. 9 de Julio, Carlos Pellegrini and Cerrito, and the layout (schematic) of intersections in the area under study.

Sidewalks are found at both sides along the service roads. Likewise, the elevated division between the main line and the service roads is also used as pedestrian walks. The pedestrian flow on the sidewalks, and crossing the main line, the service roads and the crossing streets is important. Pedestrians cross accompanying the vehicle flow without any conflict.

Traffic lights along the route operate as two phase signals with pre-defined times: one phase for the main line and a second phase for the crossing streets. No exclusive pedestrian phase is found in any of the 24 intersections within the area under study. In Ave. 9 de Julio the green interval for each crossing street is very long due to the number of lanes pedestrians have to cross. Information on traffic light timing provided by the Government of the City of Buenos Aires shows that the traffic lights located along Ave. 9 de Julio between Ave. Santa Fe and Ave. Córdoba operate on three time intervals with 100, 80 and 110 second cycles, and green light times to the main line of 55, 40 and 64 seconds respectively. Green light times in the main line between Viamonte and Moreno are 43, 40 and 49 seconds for the respective three interval plans described above. The existing traffic lights are in reasonable good condition.

In Ave. 9 de Julio and side streets the truck traffic is restricted. Buses are restricted in the main line and only allowed in the service roads. Street parking is prohibited in the whole route.

Road horizontal marking is in good condition and includes lane demarcation, stop line and pedestrian crossing at the intersections. The signal system along the route under study comprises street name signs, traffic direction signs and no-parking signs.

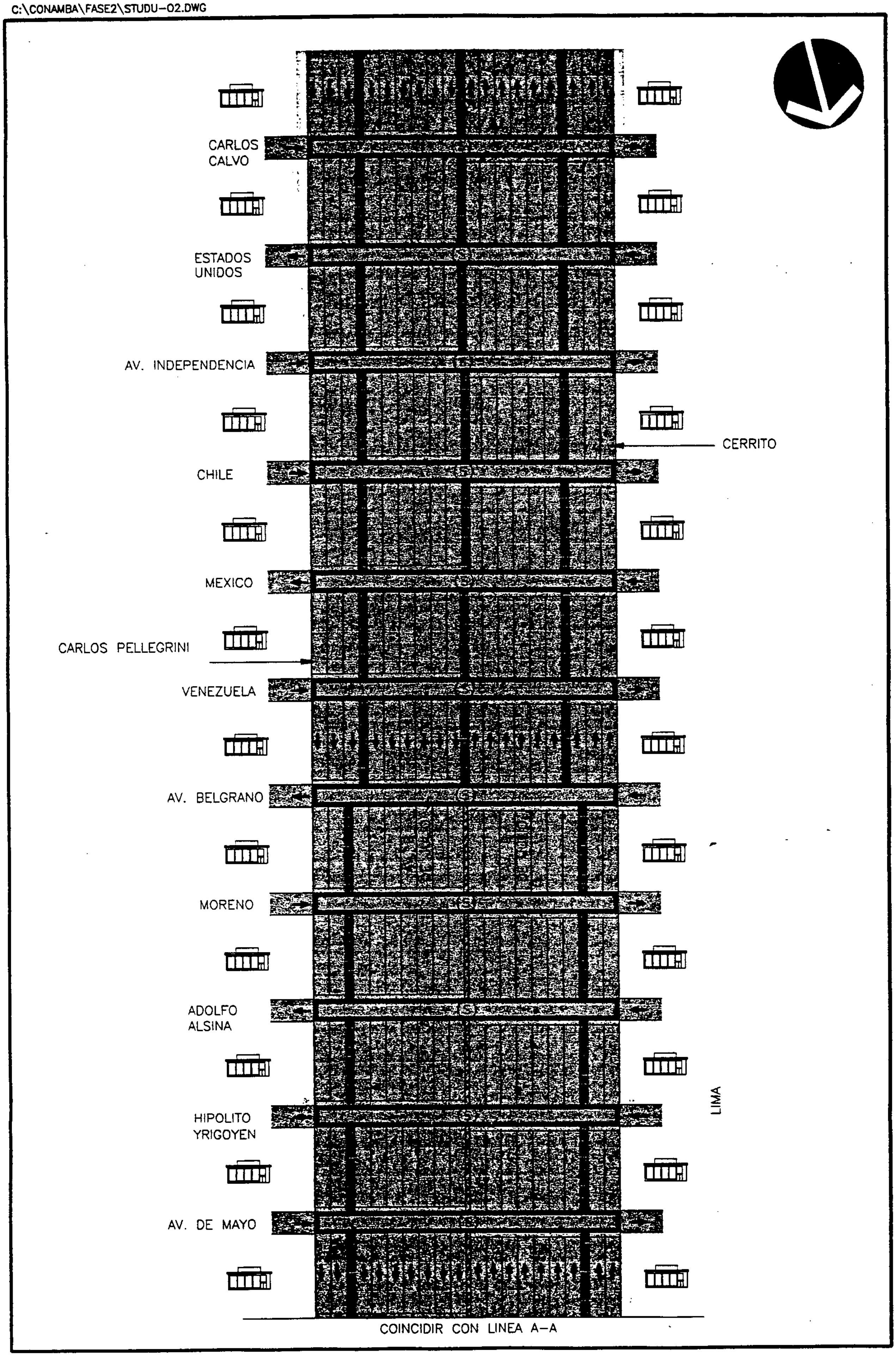


Figure 1 B

9 de Julio Ave – Existing Conditions

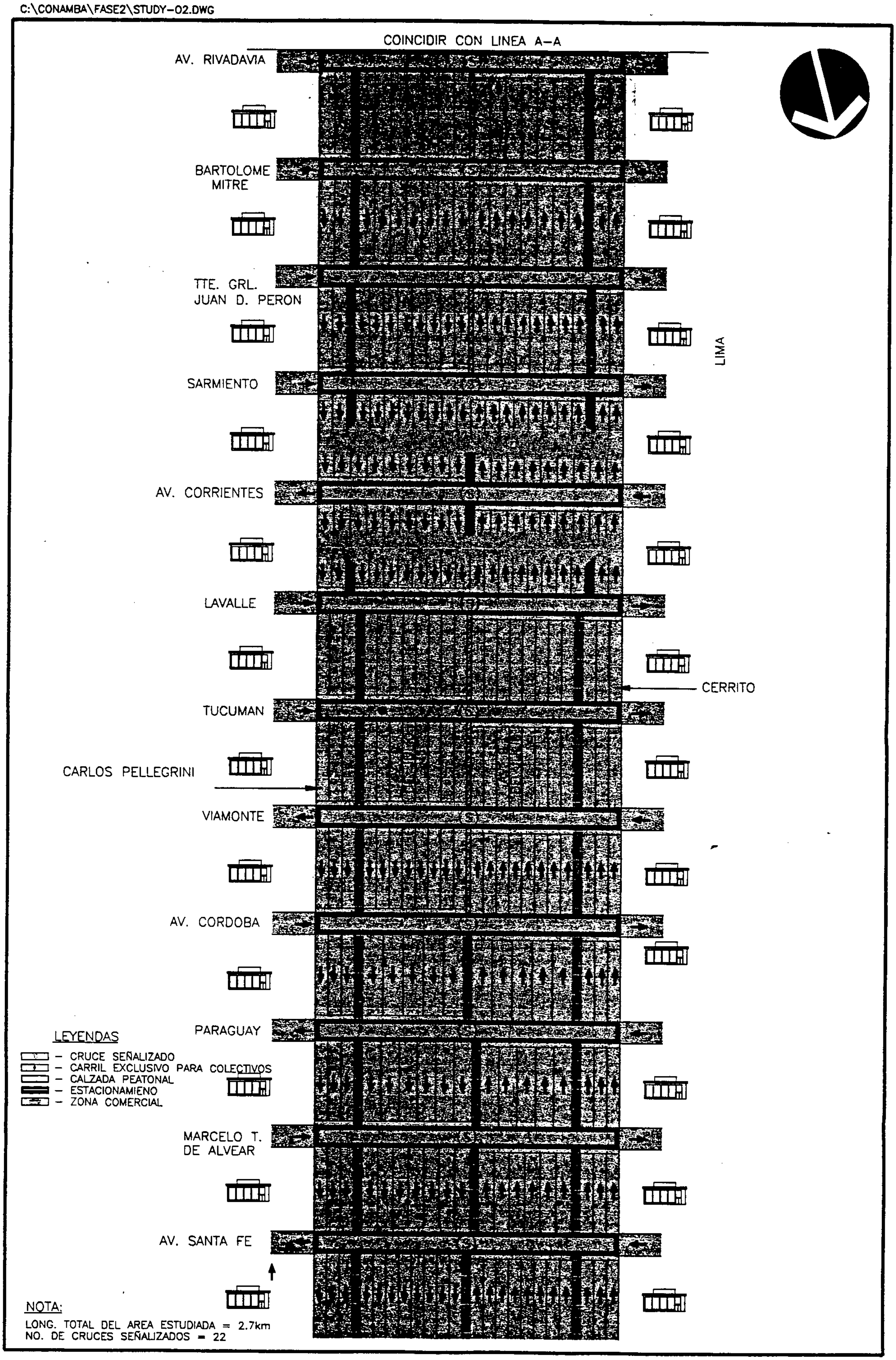


Figure 1 A

9 de Julio Ave – Existing Conditions

2.1.2 Analysis of Travel Times and Delays

The analysis of travel time and delays was made on a working day between 10:30 AM and 12:00 AM in September 1997. Two runs in each flow direction were made.

The average travel time southbound between Ave. Santa Fe and Carlos Calvo, for a total distance of 2,900 meters was 9 minutes and 20 seconds and the average speed was 18.67 kilometer per hour (km/h). Main bottlenecks were found at the beginning of the southbound trip near Ave. Corrientes and between Ave. Belgrano and Venezuela in the north end of the run. After crossing Ave. Corrientes, the five or six next intersections were crossed with green light at speeds between 42 km/h and 54 km/h. See Figures 2A and 2B.

The average northbound travel time between Ave. San Juan and Ave. Santa Fe for a distance of 3,000 meters was 10 minutes and 9 seconds. The average speed for this section was 17.8 km/h. The main bottlenecks were found near Ave. Corrientes, between Ave. Belgrano and Ave. de Mayo and near Venezuela. A maximum of four intersections were crossed with green light traveling at a speed above 30 km/h before a red signal light was found. See Figures 2C and 2D.

No travel time and delay study was conducted during the morning peak hours. According to the discussion held with UBATEC's staff, the delay for southbound vehicles during the morning peak hour near Ave. Corrientes reaches its maximum level, with a line of vehicles covering between five and six intersections.

2.1.3 Existing Deficiencies

Based on field research, travel time and delay study, and discussion held with UBATEC's traffic experts, the following existing deficiencies were identified:

- The Ave. 9 de Julio section between Ave. Santa Fe and Ave. San Juan comprises a total of 24 signaled intersections, very close together, with an average distance of 100 meters between every signaled pair. Even with the relatively large number of main lanes for any traffic bottleneck the line of vehicles covers several intersections.

- Eight (8) main lanes on the Ave. 9 de Julio and three lanes on the service streets merge into nine lanes crossing Ave. Corrientes near the Obelisk and producing therefore an important traffic bottleneck.

- This bottleneck generates during peak hours lines of vehicles covering both southbound and northbound intersections adjacent to Ave. Corrientes. The lines of vehicles and delays are more prominent during the morning peak hour (8:30 AM through 10:30 AM) in the southbound direction between Ave. Santa Fe and Ave. Corrientes, and during the evening peak hour in the northbound direction between Ave. de Mayo and Ave. Corrientes.

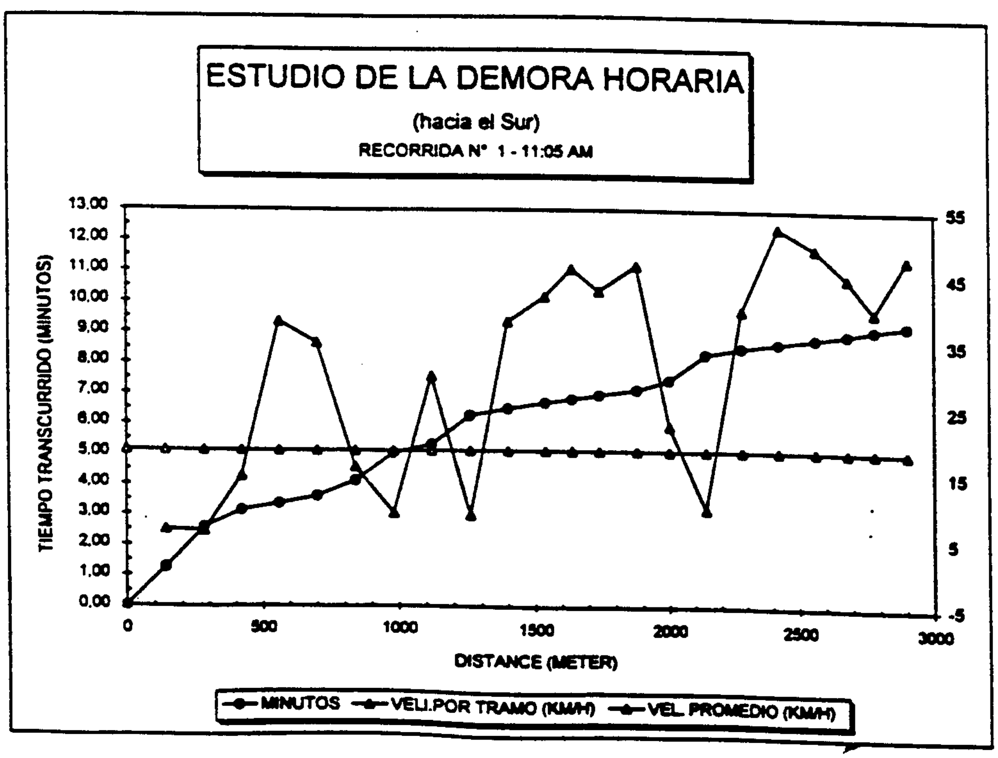
- Pedestrian traffic on Ave. 9 de Julio is very large and it accompanies the vehicle traffic light phase of the crossing street. The minimum green time required to cross Ave. 9 de Julio is long due to the large number of lanes. This situation worsens between Ave. Córdoba and Ave. Belgrano, because in this section, the elevated center island is replaced by a painted island acting as a pedestrian shelter. The information on traffic light interval provided by the local agency, shows that the green light time for street crossing is almost 50 percent of the total cycle time. The relatively shorter time for the avenue main line produces a deficient traffic flow and the development during peak hours of line of vehicles in the adjacent intersections.

- Buses contributes to traffic congestion and delays near the Obelisk, due to the merger of service roads and main line traffic near Ave. Corrientes.

Route 1 – 9 de Julio Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Av. Santa Fé	0	0.00		18.67
2	M. T. De Alvear	140	1.27	6.61	18.67
3	Paraguay	280	2.58	6.41	18.67
4	Av. Córdoba	420	3.15	14.74	18.67
5	Viamonte	560	3.37	38.18	18.67
6	Tucumán	700	3.61	35.00	18.67
7	Lavalle	840	4.13	16.15	18.67
8	Av. Corrientes	980	5.05	9.13	18.67
9	Sarmiento	1120	5.33	30.00	18.67
10	Juan D. Perón	1260	6.28	8.84	18.67
11	Bartolomé Mitre	1400	6.50	38.18	18.67
12	Av. Rivadavia	1540	6.70	42.00	18.67
13	Av. De Mayo	1640	6.83	46.15	18.67
14	Hipólito Yrigoyen	1740	6.97	42.86	18.67
15	Adolfo Alsina	1880	7.15	46.67	18.67
16	Moreno	2000	7.47	22.50	18.67
17	Av. Belgrano	2140	8.32	9.88	18.67
18	Venezuela	2280	8.53	40.00	18.67
19	México	2420	8.69	52.50	18.67
20	Chile	2560	8.86	49.41	18.67
21	Av. Independencia	2680	9.02	45.00	18.67
22	Estados Unidos	2780	9.17	40.00	18.67
23	Carlos Calvo	2900	9.32	48.00	18.67
AVERAGE SPEED IN THE AVENUE: 18.67					

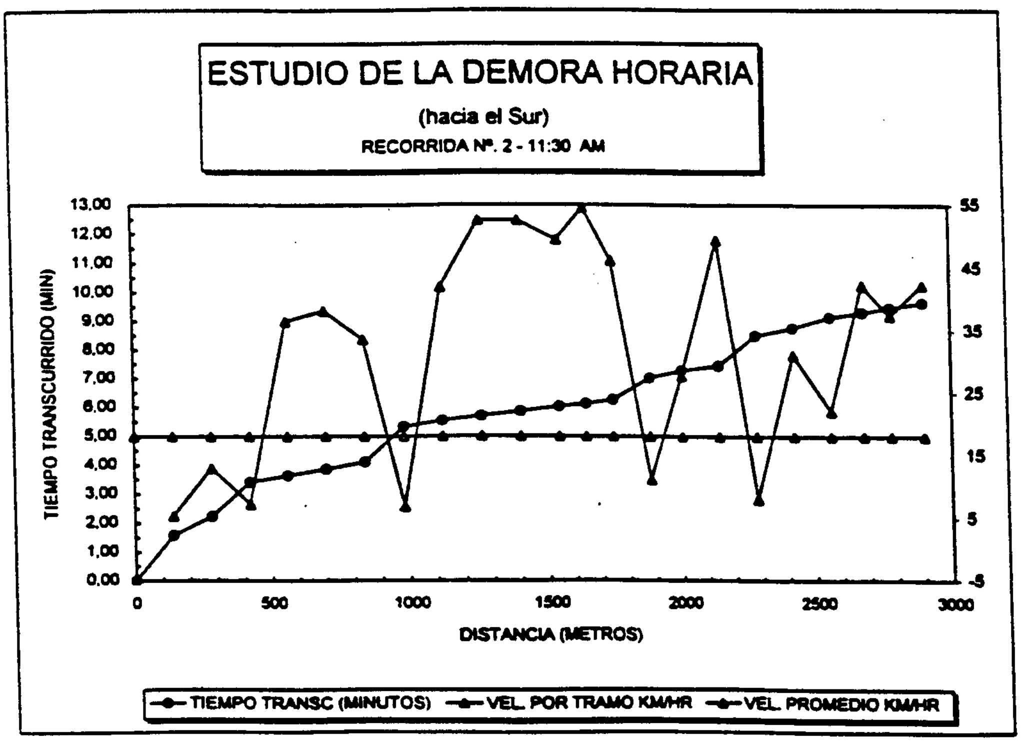
Figure 2 A - 9 de Julio Ave. – Study of the Traffic Delay



Route 1 – 9 de Julio Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Av. Santa Fé	0	0.00		18.03
2	M. T. De Alvear	140	1.58	5.32	18.03
3	Paraguay	280	2.23	12.92	18.03
4	Av. Córdoba	420	3.40	7.18	18.03
5	Viamonte	560	3.63	36.52	18.03
6	Tucumán	700	3.85	38.18	18.03
7	Lavalle	840	4.10	33.60	18.03
8	Av. Corrientes	980	5.33	6.83	18.03
9	Sarmiento	1120	5.53	42.00	18.03
10	Juan D. Perón	1260	5.69	52.50	18.03
11	Bartolomé Mitre	1400	5.85	52.50	18.03
12	Av. Rivadavia	1540	6.02	49.41	18.03
13	Av. De Mayo	1640	6.13	54.55	18.03
14	Hipólito Yrigoyen	1740	6.26	46.15	18.03
15	Adolfo Alsina	1880	7.02	11.05	18.03
16	Moreno	2000	7.28	27.69	18.03
17	Av. Belgrano	2140	7.45	49.41	18.03
18	Venezuela	2280	8.50	8.00	18.03
19	México	2420	8.77	31.11	18.03
20	Chile	2560	9.15	22.11	18.03
21	Av. Independencia	2680	9.32	42.35	18.03
22	Estados Unidos	2780	9.48	37.50	18.03
23	Carlos Calvo	2900	9.65	42.35	18.03
AVERAGE SPEED IN THE AVENUE: 18.03					

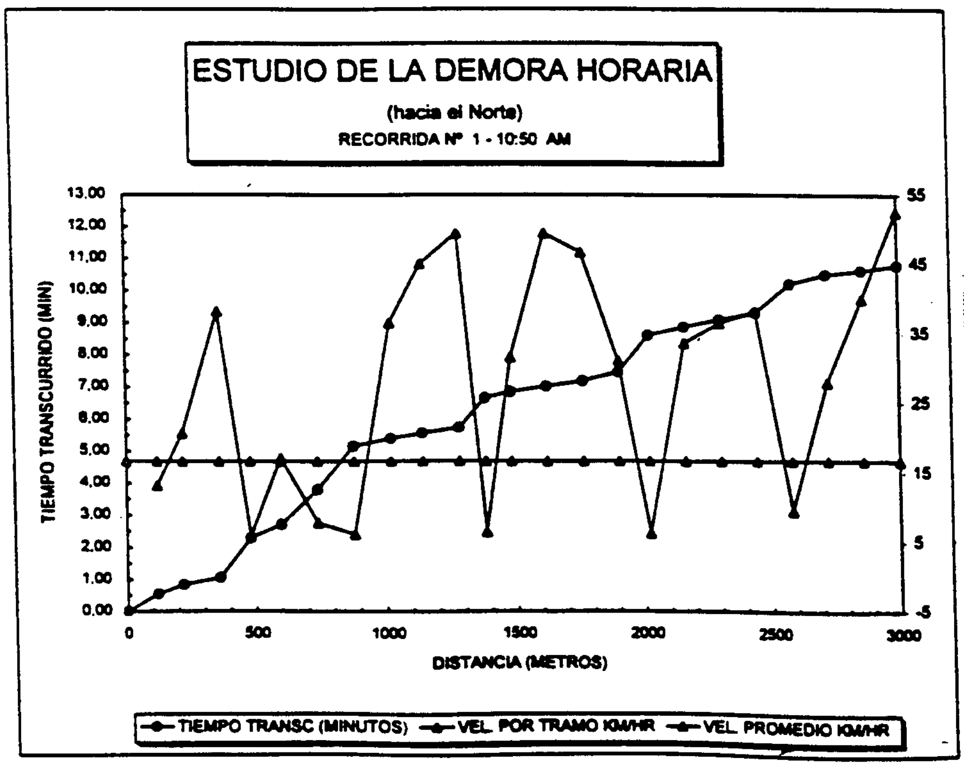
Figure 2 B - 9 de Julio Ave. – Study of the Traffic Delay



Route 1 – 9 de Julio Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
24	Av. San Juan	0	0.00		18.68
23	Carlos Calvo	120	0.55	13.09	18.68
22	Paraguay	220	0.84	20.69	18.68
21	Av. Independencia	360	1.06	38.18	18.68
20	Viamonte	480	2.30	5.81	18.68
19	México	600	2.72	17.14	18.68
18	Venezuela	740	3.80	7.78	18.68
17	Av. Belgrano	880	5.17	6.13	18.68
16	Moreno	1020	5.40	36.52	18.68
15	Adolfo Alsina	1140	5.56	45.00	18.68
14	Bartolomé Mitre	1280	5.73	49.41	18.68
13	Av. De Mayo	1380	6.66	6.45	18.68
12	Av. Rivadavia	1480	6.85	31.58	18.68
11	Bartolomé Mitre	1620	7.02	49.41	18.68
10	Juan D. Perón	1760	7.20	46.67	18.68
9	Sarmiento	1900	7.47	31.11	18.68
8	Av. Corrientes	2020	8.62	6.26	18.68
7	Lavalle	2160	8.87	33.60	18.68
6	Tucumán	2300	9.10	36.52	18.68
5	Viamonte	2440	9.32	38.18	18.68
4	Av. Córdoba	2580	10.21	9.44	18.68
3	Paraguay	2720	10.51	28.00	18.68
2	Estados Unidos	2860	10.63	40.00	18.68
1	Av. Santa Fé	3000	10.79	52.50	18.68
AVERAGE SPEED IN THE AVENUE: 18.68					

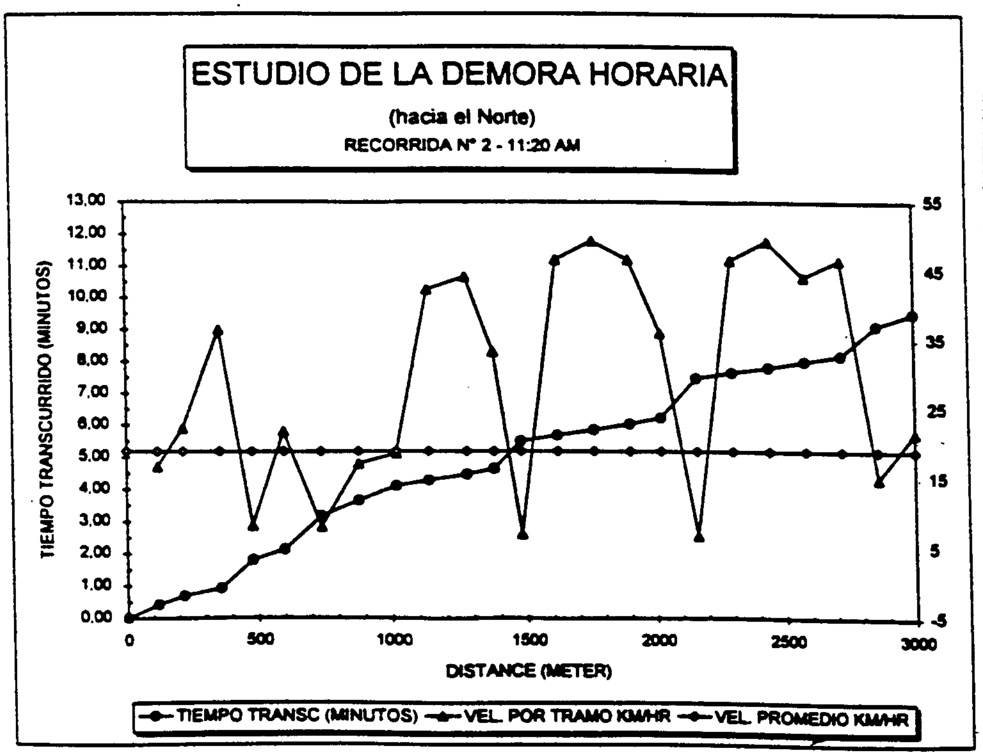
Figure 2 C - 9 de Julio Ave. – Study of the Traffic Delay



Route 1 – 9 de Julio Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
24	Av. San Juan	0	0.00		18.91
23	Carlos Calvo	120	0.43	16.74	18.91
22	Paraguay	220	0.70	22.22	18.91
21	Av. Independencia	360	0.93	36.52	18.91
20	Viamonte	480	1.80	8.28	18.91
19	México	600	2.13	21.82	18.91
18	Venezuela	740	3.17	8.08	18.91
17	Av. Belgrano	880	3.66	17.14	18.91
16	Moreno	1020	4.11	18.67	18.91
15	Adolfo Alsina	1140	4.28	42.35	18.91
14	Bartolomé Mitre	1280	4.47	44.21	18.91
13	Av. De Mayo	1380	4.65	33.33	18.91
12	Av. Rivadavia	1480	5.50	70.6	18.91
11	Bartolomé Mitre	1620	5.68	46.67	18.91
10	Juan D. Perón	1760	5.85	49.41	18.91
9	Sarmiento	1900	6.03	46.67	18.91
8	Av. Corrientes	2020	6.23	36.00	18.91
7	Lavalle	2160	7.47	6.77	18.91
6	Tucumán	2300	7.65	46.67	18.91
5	Viamonte	2440	7.82	49.41	18.91
4	Av. Córdoba	2580	8.01	44.21	18.91
3	Paraguay	2720	8.19	46.67	18.91
2	Estados Unidos	2860	9.13	15.00	18.91
1	Av. Santa Fé	3000	9.52	21.54	18.91
AVERAGE SPEED IN THE AVENUE: 18.91					

Figure 2 D - 9 de Julio Ave. – Study of the Traffic Delay



2.2 *Route 2: Avenida Pueyrredón*

2.2.1 Inventory and Field Data

Ave. Pueyrredón is a southbound one way urban artery. The number of lanes in Ave. Pueyrredón varies between five (5) and six (6). At the beginning of the project area between Ave. Las Heras and Arenales street there are five lanes for general use. North of Arenales up to Ave. Córdoba, the lane configuration changes to three (3) for general use and two (2) for exclusive use of buses. North of Ave. Córdoba the lane configuration changes to four (4) for general use and two (2) bus lanes, continuing up the intersection with Pte. Perón. Between Pte. Perón and Bartolomé Mitre the lane configuration changes again to five (5) general use lanes and one (1) buse lane. North of Bartolomé Mitre the exclusive bus lane ends and Ave. Pueyrredón continues as a five lane section. See Figure 3 for lane configuration.

One way streets cross Ave. Pueyrredón in the east-west direction approximately at every 100 meters, making up a typical center town network area with very close intersections.

In the area under study sidewalks are found on both sides of Ave. Pueyrredón. Pedestrian volume is high on both sides of the avenue. Pedestrian circulation includes the crossing of the main line and crossing streets, and reach a maximum at main intersections. Pedestrians cross joining the circulation of vehicles without any conflict.

The existing traffic light system along the route under study operates as two phase signals with pre-determined time: the first phase for Ave. Pueyrredón and the second for the streets crossing the avenue together with the simultaneous pedestrian phase. Since it is a single way network system and without movements that can generate conflicts, a reasonable progress was observed along the main line. The present traffic light system is relatively obsolete, and includes signals installed high above the road and on poles.

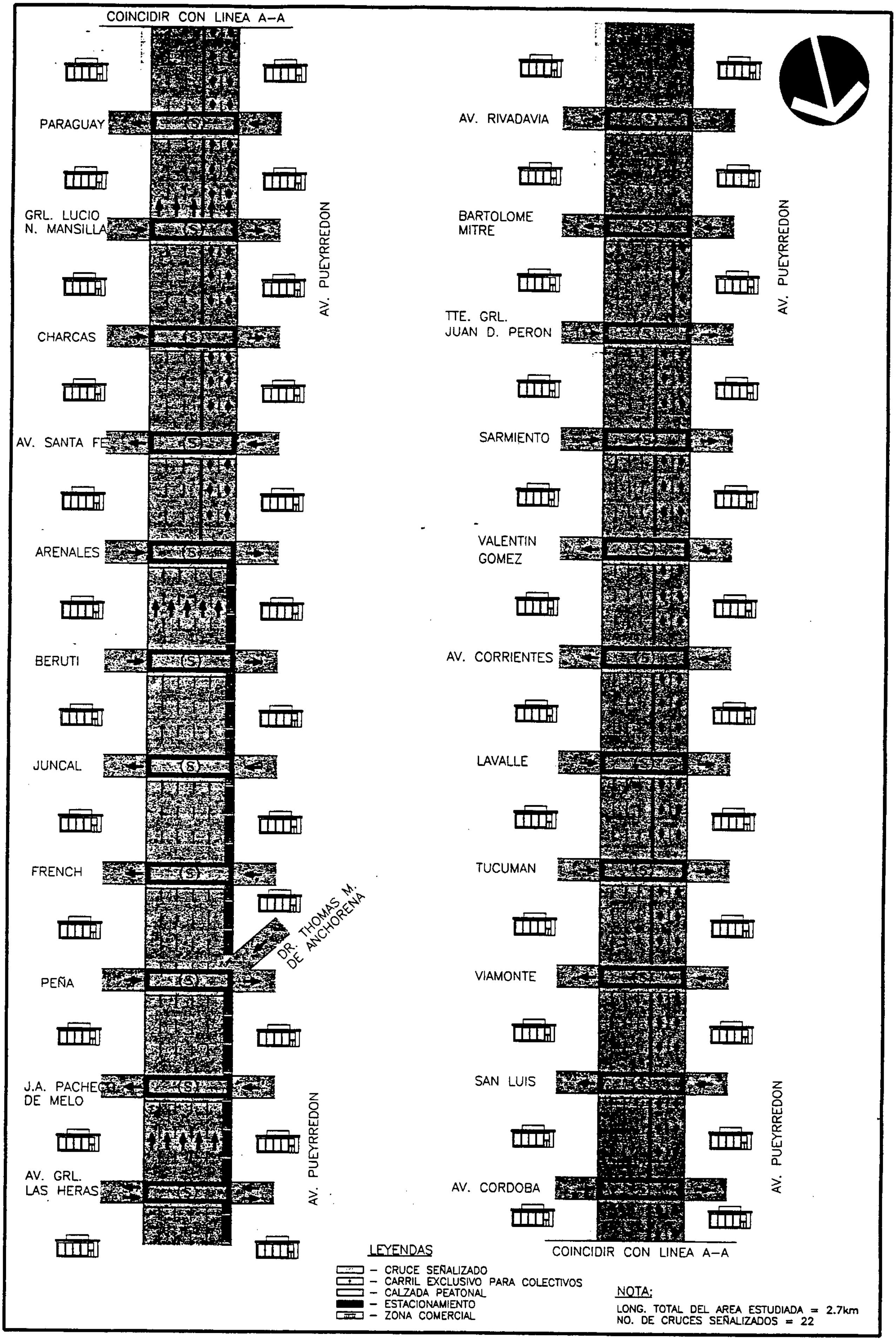


Figure 3

Pueyrredón Ave – Existing Conditions

Louis Berger & Associates, Inc.

Restrictions include one-way circulation in the southbound direction. No trucks are allowed to circulate in the avenue. Between Arenales Street and Bartolomé Mitre bus circulation is restricted to exclusive lanes. Curb parking is prohibited on both sides north of Arenales and, south of Arenales parking meters were installed only on the west curb. To illustrate present parking conditions see Figure 3.

Road marking comprises lane markings, exclusive bus lane marking, stop bar and pedestrian crossings. Condition of road marking is good, but in certain intermediate sections the marking for the exclusive bus lane is in poor condition.

The traffic light system in the area under study comprises signals posts with street names, one way signs and a few elevated signals for information to drivers. No-Parking signs are inconspicuous.

2.2.2 Analysis of Travel Time and Delays

The analysis of travel time and delays for Ave. Pueyrredón was conducted on a working day from 2:30 PM through 4:00 PM in the month of September, 1997. Three runs in total were made between Ave. Las Heras and Ave. Rivadavia.

The average southbound travel time between Ave. Las Heras and Ave. Rivadavia, a total of 2,700 meters was 18 minutes and 47 seconds for the first two runs at an average speed of 18.43 km/h. The travel time in the third run was 12 minutes and 27 seconds at an average speed of 13.01 km/h

Analysis of travel time and delays shows the existence of two different trip patterns: one south of Ave. Corrientes and the other north of such avenue. A study in detail of the travel time and delays shows that the average travel time between Ave. Las Heras and Lavalle (next intersection north of Ave. Corrientes) is 3 minutes and 13 seconds for a total distance of 1,900 meters at an average speed of 35.4 km/h; while the average trip time between Lavalle south (approaching Ave. Corrientes) and Ave. Rivadavia is 6 minutes and 24 seconds for a distance of 800 meters. The average speed in this section is 7.8 km/h. See Figures 4A and 4C for details of statistics, and trip time and delay analysis.

Good circulation was observed between Ave. Las Heras and Lavalle, and the sixteen traffic lights of this section were encountered on green with a negligible delay and very short lines of vehicles. There is neither progress nor coordination of traffic lights in the access to Ave. Corrientes and south of it. During the runs, the line of vehicles covered the whole length of road between Ave. Corrientes and Ave. Rivadavia.

2.2.3 Existing Deficiencies

Based on field investigations, the travel time and delay study, and discussions held with UBATEC's traffic experts, the following deficiencies have been identified:

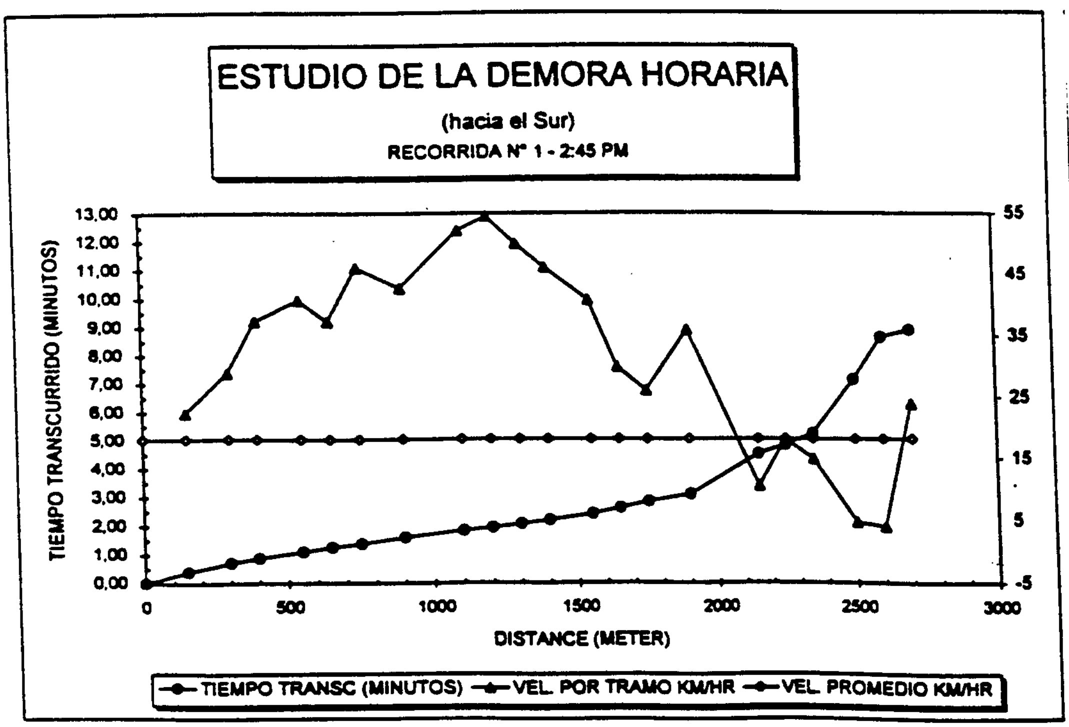
- The Ave. Pueyrredón segment between Ave. Las Heras and Ave. Rivadavia comprises a total of 22 signaled intersections very close together at a distance of 100 meters between each signal pair. With five (5) and six (6) lanes, good traffic progress is observed between close traffic signals as long as there are no bottlenecks. In case of bottleneck, for example, in a street crossing Ave. Corrientes, a line of vehicles is formed no only at the intersection at issue but in the following intersections.

- The heavy bus traffic is also a factor contributing to the traffic congestion and produces delays in the southern end of the area under study. The bus lane ends south of Bartolomé Mitre and merges with the general traffic lanes.

Route 2 – Pueyrredón Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Las Heras	0	0.00		18.24
2	Pacheco de Melo	150	0.40	22.50	18.24
3	Peña	300	0.71	29.03	18.24
4	French	400	0.87	37.50	18.24
5	Juncal	550	1.09	40.91	18.24
6	Beruti	650	1.25	37.50	18.24
7	Arenales	750	1.38	46.15	18.24
8	Av. Santa Fé	900	1.59	42.86	18.24
9	Charcas	1100	1.82	52.17	18.24
10	Lucio N. Mansilla	1200	1.93	54.55	18.24
11	Paraguay	1300	2.05	50.00	18.24
12	Av. Córdoba	1400	2.18	46.15	18.24
13	San Luis	1550	2.40	40.91	18.24
14	Viamonte	1650	2.60	30.00	18.24
15	Tucumán	1750	2.83	26.09	18.24
16	Lavalle	1900	3.08	36.00	18.24
17	Av. Corrientes	2150	4.50	10.56	18.24
18	Valentín Gómez	2250	4.83	18.18	18.24
19	Sarmiento	2350	5.23	15.00	18.24
20	Juan D. Perón	2500	7.13	4.74	18.24
21	Bartolomé Mitre	2600	8.63	4.00	18.24
22	Av. Rivadavia	2700	8.88	24.00	18.24
AVERAGE SPEED IN THE AVENUE: 18.24					

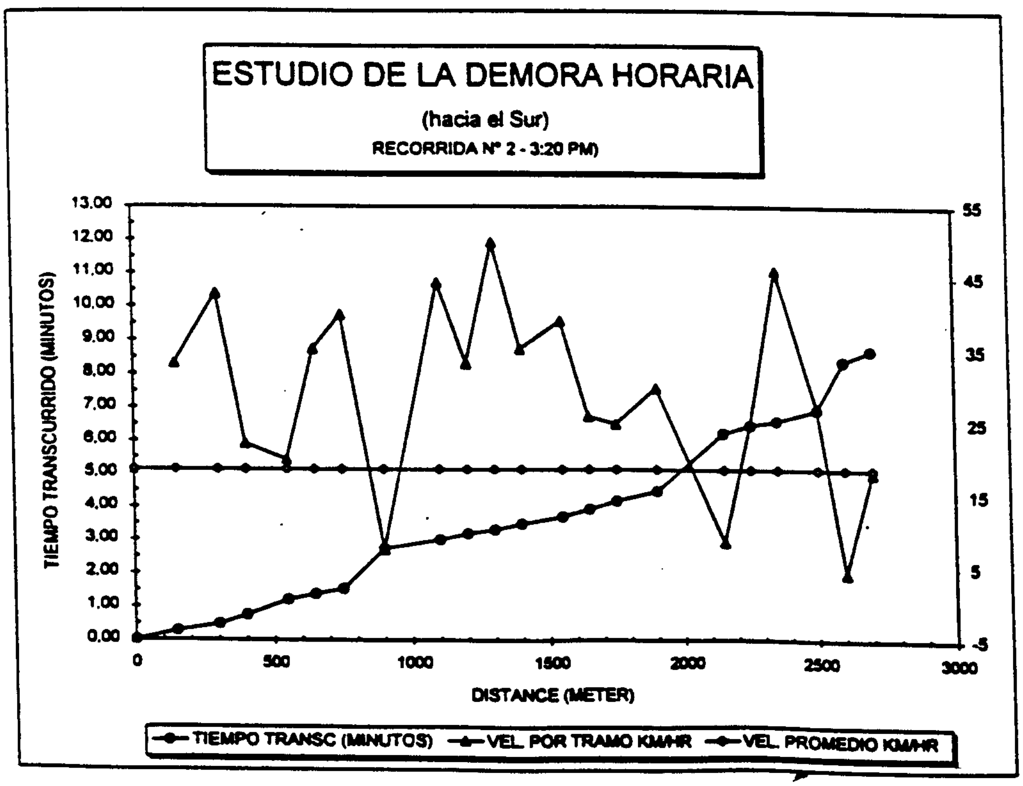
Figure 4 A – Pueyrredón Ave. – Study of the Traffic Delay



Route 2 – Pueyrredón Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Las Heras	0	0.00		18.62
2	Pacheco de Melo	150	0.27	33.33	18.62
3	Peña	300	0.48	42.86	18.62
4	French	400	0.75	22.22	18.62
5	Juncal	550	1.20	20.00	18.62
6	Beruti	650	1.37	35.29	18.62
7	Arenales	750	1.52	40.00	18.62
8	Av. Santa Fé	900	2.73	7.44	18.62
9	Charcas	1100	3.00	44.44	18.62
10	Lucio N. Mansilla	1200	3.18	33.33	18.62
11	Paraguay	1300	3.30	50.00	18.62
12	Av. Córdoba	1400	3.47	35.29	18.62
13	San Luis	1550	3.70	39.13	18.62
14	Viamonte	1650	3.93	26.09	18.62
15	Tucumán	1750	4.17	25.00	18.62
16	Lavalle	1900	4.47	30.00	18.62
17	Av. Corrientes	2150	6.23	8.52	18.62
18	Valentin Gómez	2250	6.47	25.00	18.62
19	Sarmiento	2350	6.60	46.15	18.62
20	Juan D. Perón	2500	6.93	27.27	18.62
21	Bartolomé Mitre	2600	8.37	4.17	18.62
22	Av. Rivadavia	2700	8.70	18.18	18.62
AVERAGE SPEED IN THE AVENUE: 18.62					

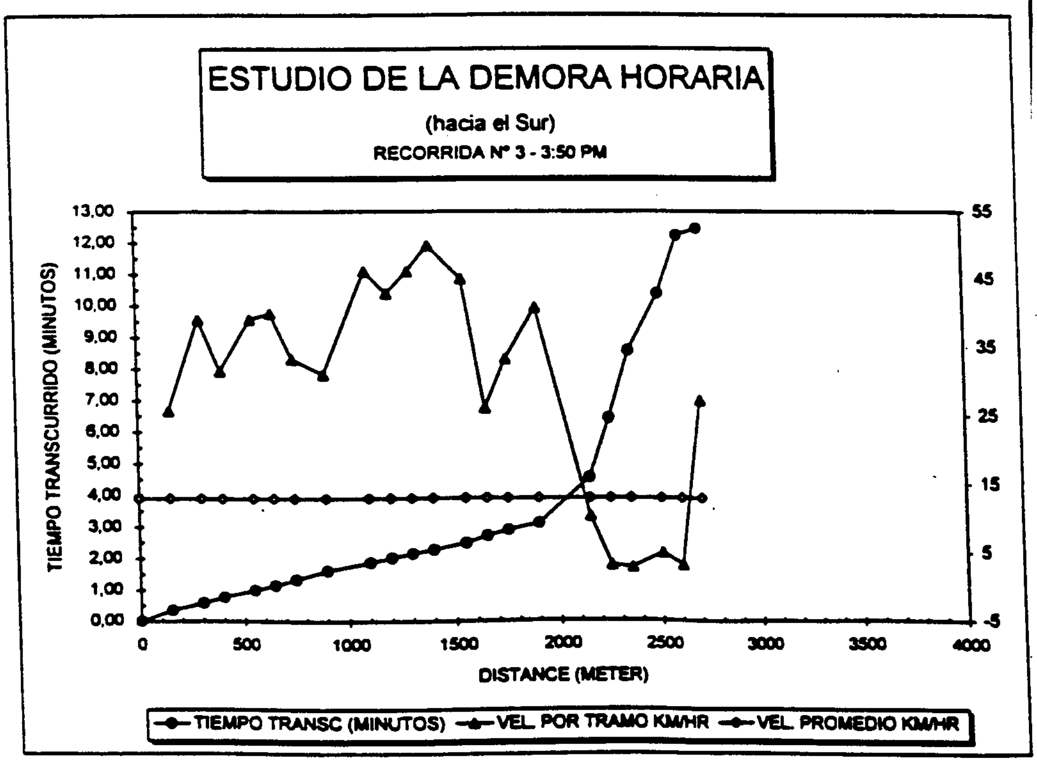
Figure 4 B – Pueyrredón Ave. – Study of the Traffic Delay



Route 2 – Pueyrredón Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Las Heras	0	0.00		13.01
2	Pacheco de Melo	150	0.35	25.71	13.01
3	Peña	300	0.58	39.13	13.01
4	French	400	0.77	31.58	13.01
5	Juncal	550	1.00	39.13	13.01
6	Beruti	650	1.15	40.00	13.01
7	Arenales	750	1.33	33.33	13.01
8	Av. Santa Fé	900	1.62	31.03	13.01
9	Charcas	1100	1.88	46.15	13.01
10	Lucio N. Mansilla	1200	2.02	42.86	13.01
11	Paraguay	1300	2.15	46.15	13.01
12	Av. Córdoba	1400	2.27	50.00	13.01
13	San Luis	1550	2.47	45.00	13.01
14	Viamonte	1650	2.70	26.09	13.01
15	Tucumán	1750	2.88	33.33	13.01
16	Lavalle	1900	3.10	40.91	13.01
17	Av. Corrientes	2150	4.55	10.34	13.01
18	Valentín Gómez	2250	6.42	3.21	13.01
19	Sarmiento	2350	8.57	2.79	13.01
20	Juan D. Perón	2500	10.38	4.97	13.01
21	Bartolomé Mitre	2600	12.23	3.24	13.01
22	Av. Rivadavia	2700	12.45	27.27	13.01
AVERAGE SPEED IN THE AVENUE: 13.01					

Figure 4 C – Pueyrredón Ave. – Study of the Traffic Delay



2.3 *Route 3: Avenida Pavón / Avenida Hipólito Yrigoyen*

2.3.1 Inventory and Field Data

Ave. Pavón is a six lane two way urban artery with median connecting the Federal Capital and Avellaneda, Province of Buenos Aires, and extends south up to Lanús, Province of Buenos Aires. Upon entering Lanús, Ave. Pavón changes into Ave. Hipólito Yrigoyen. The one meter wide median separates both traffic ways. In the whole length of the area under study between Ave. Bartolomé Mitre and San Martín each way has three (3) lanes. Crossing streets intersect the main line in the east-west direction at distances varying between 100 and 300 meters to make up a group of signaled intersections at short distances between them. See Figure 5 for lane configuration along the whole extension of Ave. Pavón, Ave. and Hipólito Yrigoyen, as well as the intersection layout.

In the area under study sidewalks are found at both sides of Ave. Pavón and Ave. Yrigoyen. Pedestrian volume is moderate in the intermediate section and heavy in the main intersections. Pedestrian movements, including crossing of the main line and crossing streets, is more significant at main intersections. Pedestrian cross simultaneously with the movement of vehicles without conflict.

The existing traffic lights operate as two phase signals with pre-determined times: the first phase for the main line and the second phase for the crossing streets together with the simultaneous pedestrian phase. There is also a left turn protected phase at the intersection of Ave. Pavón and Cabildo in the northern direction. The existing traffic light system is fairly old and includes signals installed high above the road and on poles.

No existing operational restrictions were observed in the main line. There is a one way circulation restriction in the crossing streets. There are not parking restrictions on the road and vehicles parked on both sides were observed along the whole Ave. Pavón and Ave. Yrigoyen. South of Chile, the right lane is very spacious and three lane circulation was observed with vehicles parked on this side, but between Ave. Bartolomé Mitre and Chile parked vehicles interfere with the circulation on the right lane.

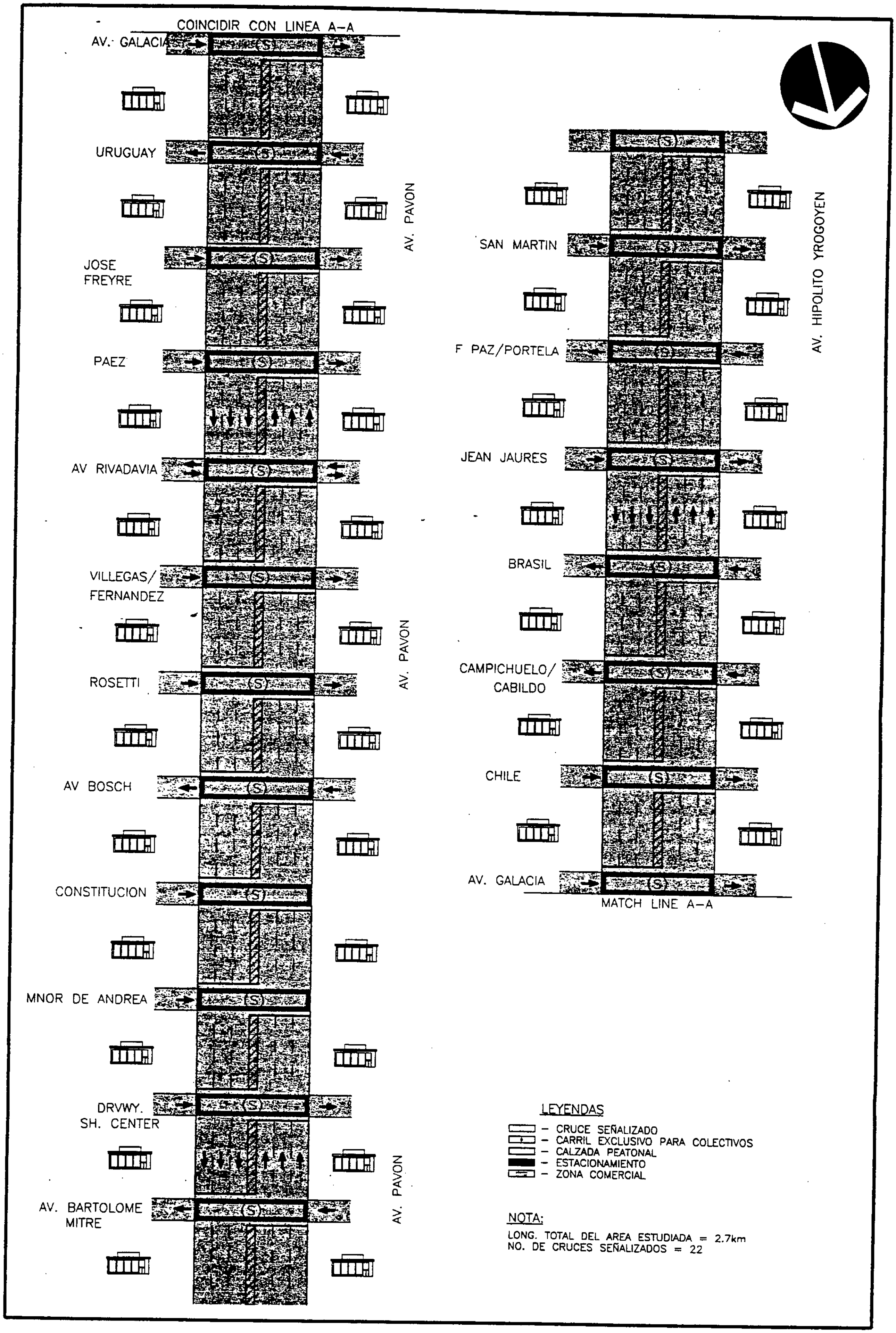


Figure 5

Pavon/Hipolito Yrigoyen Ave – Existing Conditions

The use of land in the area of the project is strictly commercial, specially retail stores, car dealers, gas stations and restaurants.

Existing road marking comprises lane marking, stop bars, and pedestrian crossings at intersections. Road marking is in good condition.

Deficient signals are observed along Ave. Pavón and Ave. Yrigoyen. In a few intersections the street name signs are missing. In very few intermediate places speed limit signs were observed (Speed limit 40 km/h).

The area under study shows a large commercial traffic volume including buses and trucks.

2.3.2 Analysis of Travel Time and Delays

The analysis of travel time and delays in Ave. Pavón and Ave. Yrigoyen was conducted on a working day from 4:30 PM through 6:00 PM in the month of September, 1997. Two runs in both directions were made.

The average southbound travel time between Ave. Bartolomé Mitre and San Martín, a total distance of 4,000 meters was 10 minutes and 47 seconds, at an average speed of 22.6 km/h. The longest delay took place at the intersection of Ave. Rivadavia. Some delays were observed in the northern and southern ends of the project. See Figures 6A and 6B for more details on the statistics and analysis of the travel time and delays.

The average northbound travel time between San Martín and the entrance to the shopping center, a total distance of 3,800 meters was 8 minutes and 51 seconds at an average speed of 25.8 km/h. The longest delay took place at the southern end of the project near Jean Jaures. Progress was not very good, with at least six (6) stops for red traffic lights while traveling north. See Figures 6C and 6D for more details on statistics for study of travel time and delay.

2.3.3 Existing Deficiencies

Based on field investigations, the travel time and delay study, and discussions held with UBATEC's traffic experts, the following deficiencies have been identified:

- The section between Ave. Pavón and Ave. Hipólito Yrigoyen comprises a total of 18 intersections, close together, at a distance of 200 meters between any two pairs. The distance between pairs of traffic lights is shorter in the northern end, where the five traffic lights between Rosetti and the entrance to the Shopping Center are spaced less than 500 meters. In this section of the route, the delays and lines of vehicle are more important.

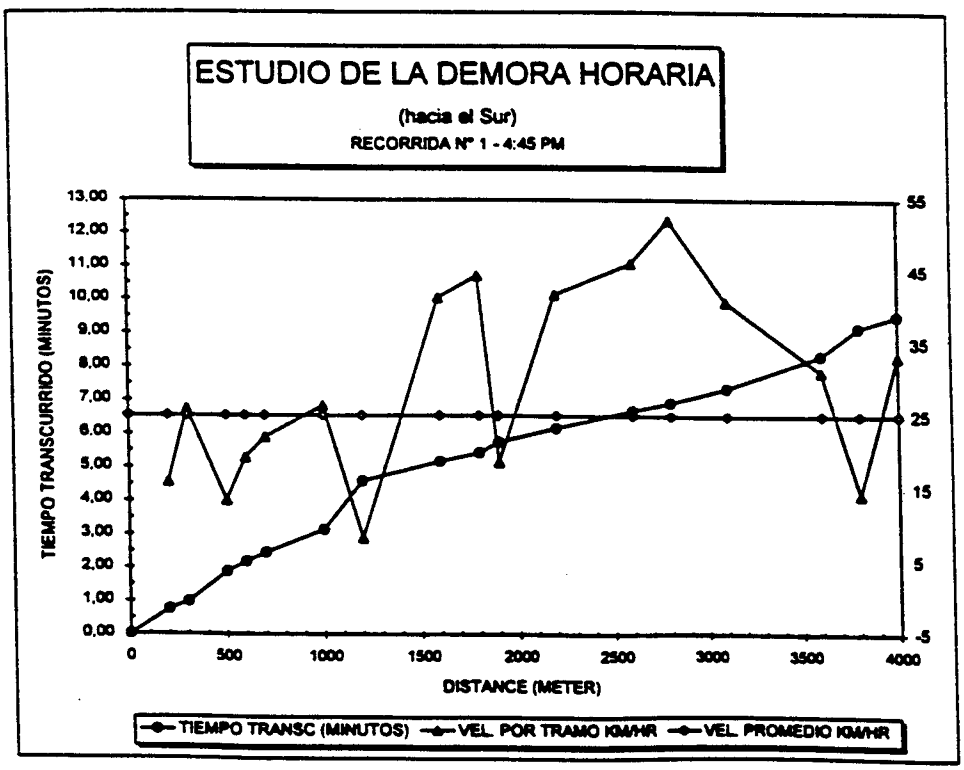
- Traffic light advance is not very good both in the northbound and southbound directions. One of the reason for this action may the fact that the present traffic light system is obsolete.

- The existing traffic signs along the route are not very good, and require a major work together with the road marking in order to improve the traffic operation along the route.

Route 3 – Pavón Ave. / Hipólito Yrigoyen Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Av. Bartolomé Mitre	0	0.00		25.18
2	Drvwy. Sh Center	200	0.75	16.00	25.18
3	Mnor de Andrea	300	0.98	26.09	25.18
4	Constitución	500	1.87	13.48	25.18
5	Av. Bosch	600	2.18	19.35	25.18
6	Rosetti	700	2.45	22.22	25.18
7	Villegas / Fernandez	1000	3.13	26.47	25.18
8	Av. Rivadavia	1200	4.58	8.28	25.18
9	Paez	1600	5.16	41.38	25.18
10	José Freyere	1800	5.43	44.44	25.18
11	Uruguay	1900	5.75	18.75	25.18
12	Av. Galicia	2200	6.18	41.83	25.18
13	Chile	2600	6.70	46.15	25.18
14	Campichuelo / Cabildo	2800	6.93	52.17	25.18
15	Brasil	3100	7.37	40.91	25.18
16	Jean Jaures	3600	8.33	31.25	25.18
17	F. Paz / Portela	3800	9.17	14.29	25.18
18	San Martín	4000	9.53	33.33	25.18
AVERAGE SPEED IN THE AVENUE: 25.18					

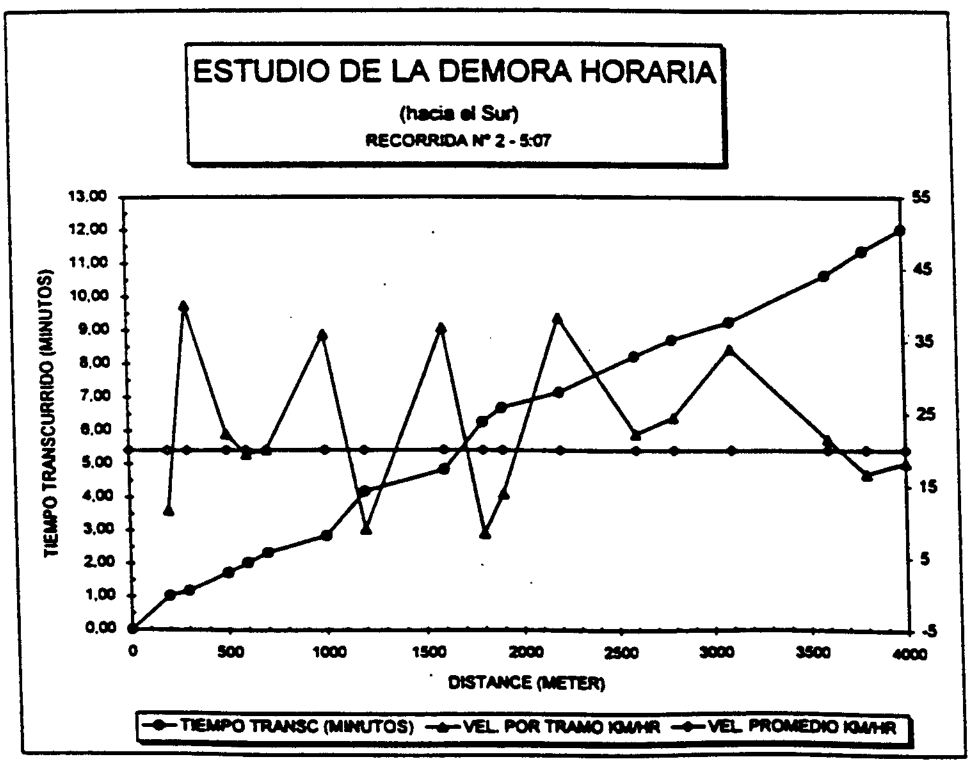
Figure 6 A – Pavón Ave./Hipólito Yrigoyen Ave. – Study of the Traffic Delay



Route 3 – Pavón Ave. / Hipólito Yrigoyen Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Av. Bartolomé Mitre	0	0.00		19.95
2	Drvwy. Sh Center	200	1.03	11.65	19.95
3	Mnor de Andrea	300	1.18	40.00	19.95
4	Constitución	500	1.72	22.22	19.95
5	Av. Bosch	600	2.03	19.35	19.95
6	Rosetti	700	2.33	20.00	19.95
7	Villegas / Fernandez	1000	2.83	36.00	19.95
8	Av. Rivadavia	1200	4.17	8.96	19.95
9	Paez	1600	4.82	36.92	19.95
10	José Freyere	1800	6.25	8.39	19.95
11	Uruguay	1900	6.68	13.95	19.95
12	Av. Galicia	2200	7.15	38.30	19.95
13	Chile	2600	8.23	22.22	19.95
14	Campichuelo / Cabildo	2800	8.72	24.49	19.95
15	Brasil	3100	9.25	33.96	19.95
16	Jean Jaures	3600	10.65	21.43	19.95
17	F. Paz / Portela	3800	11.37	16.67	19.95
18	San Martín	4000	12.03	18.18	19.95
AVERAGE SPEED IN THE AVENUE: 19.95					

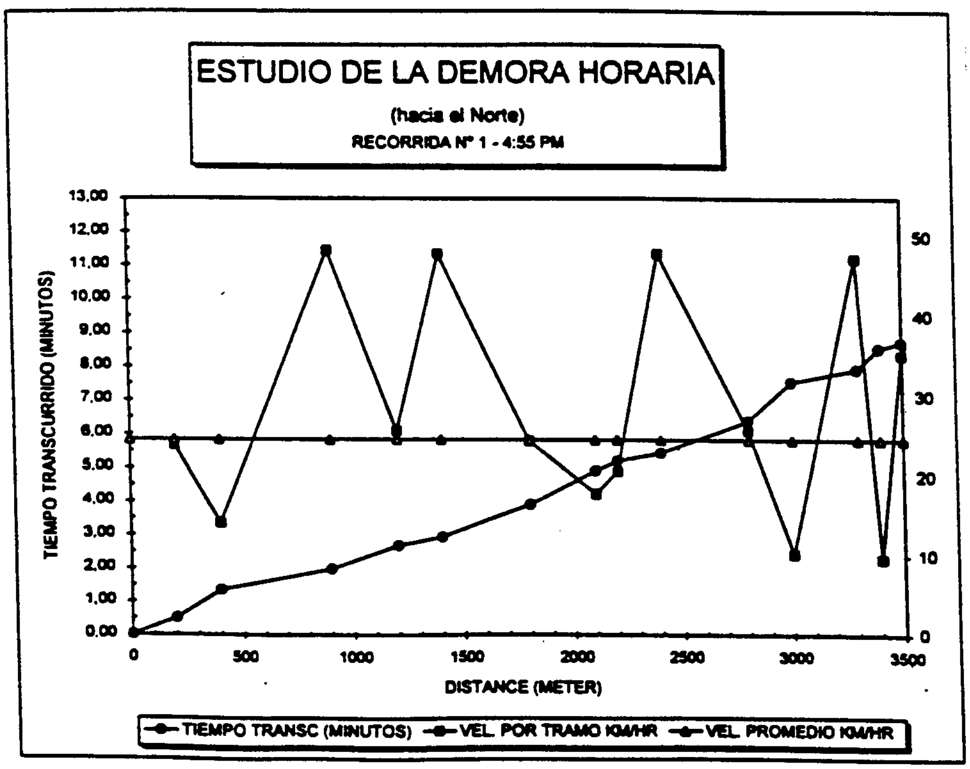
Figure 6 B – Pavón Ave./Hipólito Yrigoyen Ave. – Study of the Traffic Delay



Route 3 – Pavón Ave. / Hipólito Yrigoyen Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
18	San Martín	0	0.00		24.65
17	F. Paz / Portela	200	0.50	24.00	24.65
16	Jean Jaures	300	1.35	14.12	24.65
15	Brasil	500	1.97	48.39	24.65
14	Campichuelo / Cabildo	600	2.67	25.71	24.65
13	Chile	700	2.92	48.00	24.65
12	Av. Galicia	1000	3.90	24.49	24.65
11	Uruguay	1200	4.91	17.82	24.65
10	José Freyere	1600	5.20	20.69	24.65
9	Paez	1800	5.45	48.00	24.65
8	Av. Rivadavia	1900	6.38	25.81	24.65
7	Villegas / Fernandez	2200	7.55	10.26	24.65
6	Rosetti	2600	7.93	47.37	24.65
5	Av. Bosch	2800	8.55	9.68	24.65
4	Constitución	3100	8.72	35.29	24.65
3	Mnor de Andrea	3600	8.97	48.00	24.65
2	F. Paz / Portela	3800	9.25	21.43	24.65
1	Av. Bartolomé Mitre	4000			
AVERAGE SPEED IN THE AVENUE: 24.65					

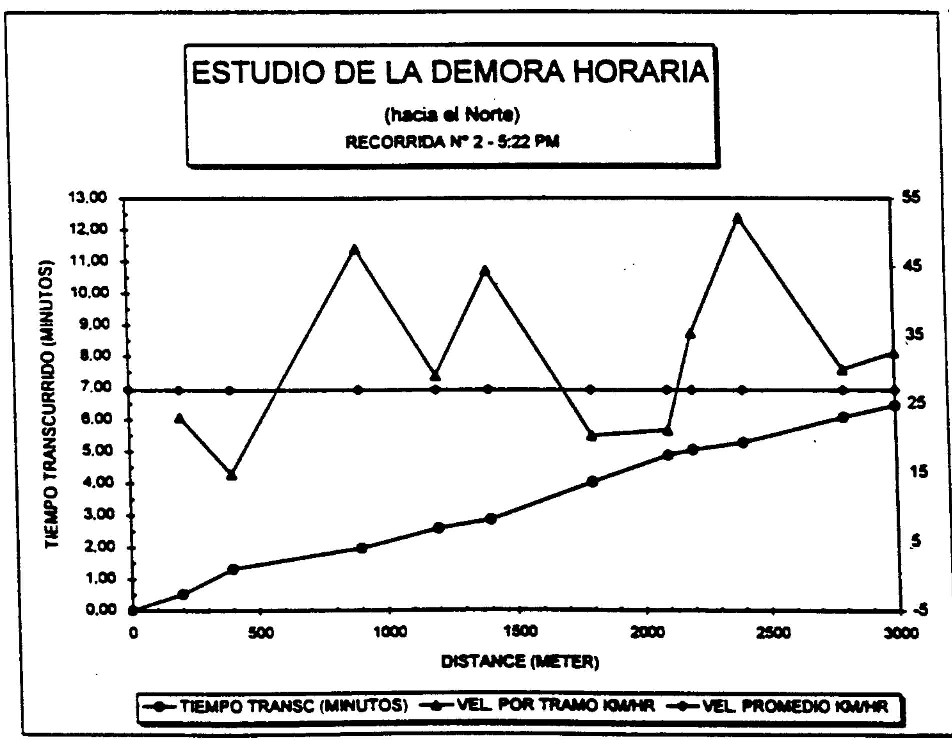
Figure 6 C – Pavón Ave./Hipólito Yrigoyen Ave. – Study of the Traffic Delay



Route 3 – Pavón Ave. / Hipólito Yrigoyen Ave.

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
18	San Martín	0	0.00		26.98
17	F. Paz / Portela	200	0.52	23.08	26.98
16	Jean Jaures	300	1.33	14.81	26.98
15	Brasil	500	1.96	47.62	26.98
14	Campichuelo / Cabildo	600	2.58	29.03	26.98
13	Chile	700	2.85	44.44	26.98
12	Av. Galicia	1000	4.03	20.34	26.98
11	Uruguay	1200	4.88	21.18	26.98
10	José Freyere	1600	5.05	35.29	26.98
9	Paez	1800	5.28	52.17	26.98
8	Av. Rivadavia	1900	6.08	30.00	26.98
7	Villegas / Fernandez	2200	6.45	32.43	26.98
6	Rosetti	2600	7.12	26.87	26.98
5	Av. Bosch	2800	7.30	33.33	26.98
4	Constitución	3100	7.52	27.27	26.98
3	Mnor de Andrea	3600	8.27	16.00	26.98
2	F. Paz / Portela	3800	8.45	33.33	26.98
1	Av. Bartolomé Mitre	4000			
AVERAGE SPEED IN THE AVENUE: 26.98					

Figure 6 D – Pavón Ave./Hipólito Yrigoyen Ave. – Study of the Traffic Delay



2.4 *Route 4: Provincial Route 202*

2.4.1 Inventory and Field Data

Routė 202 is two way two lane rural road without any median running from San Fernando, Province of Buenos Aires in the north to Mariano Moreno, Province of Buenos Aires in the south. The section of Route 202 selected for this analysis is located in San Fernando with an approximate length of 5.9 km running from the railroad Malvinas bridge in the south up to Ave. Juan D. Perón in the north. In the area under study Route 202 has one lane in each direction. There are neither curbs nor paved shoulders between the railroad bridge and Ave. Intendente Arnoldi in the southern end of the project. Crossing streets intersect Route 202 in the east-west direction to make up intersections with three or four branches. Most of the crossing streets within the area of the project are two-way streets. The use of land is variable. South of Ave. Arnoldi it is residential mixed with some light industrial plants and north of Ave. Arnoldi a combination of commercial and residential. The commercial use of land is mainly dedicated to retail stores, with a few gas stations. See Figure 7 for the existing lane configuration and layout of intersections.

There are sidewalks in the south end of the project; starting north of Ave. Arnaldi and continue on both sides up to Ave. Juan D. Perón. Pedestrian volume is very high between the railroad bridge and Ave. Sobremonte and reaches a medium level north of Ave. Sobremonte.

The existing traffic lights along the Route 202 operate as two phase signals with pre-determined times: the first phase for the main line and the second for the crossing streets. There is not an exclusive pedestrian phase in any location, except for the intermediate pedestrian signal in the Place N° 3 (Lugar N° 3). The distance between traffic lights is regularly distributed along the route. In the project northern end there are traffic lights installed closer together: north of Suipacha there are six (6) traffic lights in a span of 1,900 meters. Existing signals are not in good condition and require immediate repair.

Route 202 does not have restrictions related to the existing traffic operations. There are not restrictions on road parking, but due to the reduced road width, no parked vehicles were observed along the route.

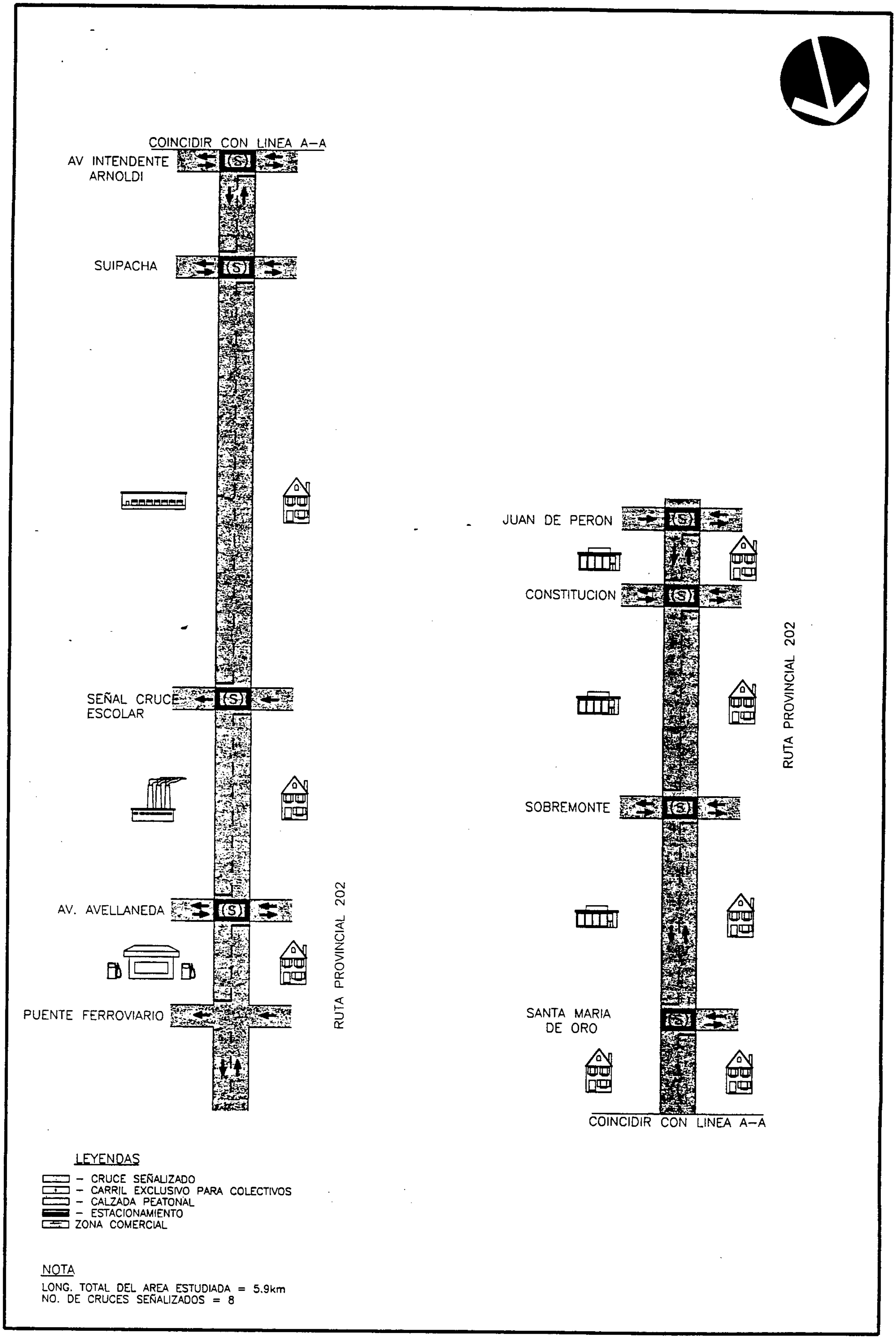


Figure 7

Ruta Provincial 202 – Existing Conditions

Road marking is very deficient. There is not visible road marking south of Suipacha. North of Suipacha we found lane marking, stop bars and pedestrian crossing markings in intersections having traffic lights.

Signals along the whole route are very deficient. There are very few street name signs, speed limit and other traffic regulation signs.

The commercial traffic volume is very high. Buses and trucks make up almost 20% of the total traffic volume.

2.4.2 Analysis of Travel Time and Delays

The analysis of travel time and delays in Route 202 was conducted on a working day from 10:30 AM through 12:00 AM in the month of September, 1997. Two runs in both directions were made.

The average northbound travel time between the railroad bridge and Ave. Juan D. Perón was 12 minutes and 26 seconds, at an average speed of 28.5 km/h. The maximum travel speed of more than 40 km/h was reached between the pedestrian signal in the intermediate section and Suipacha. See Figures 8A and 8B for more details on the statistic and travel time and delay analysis.

2.4.3 Existing Deficiencies

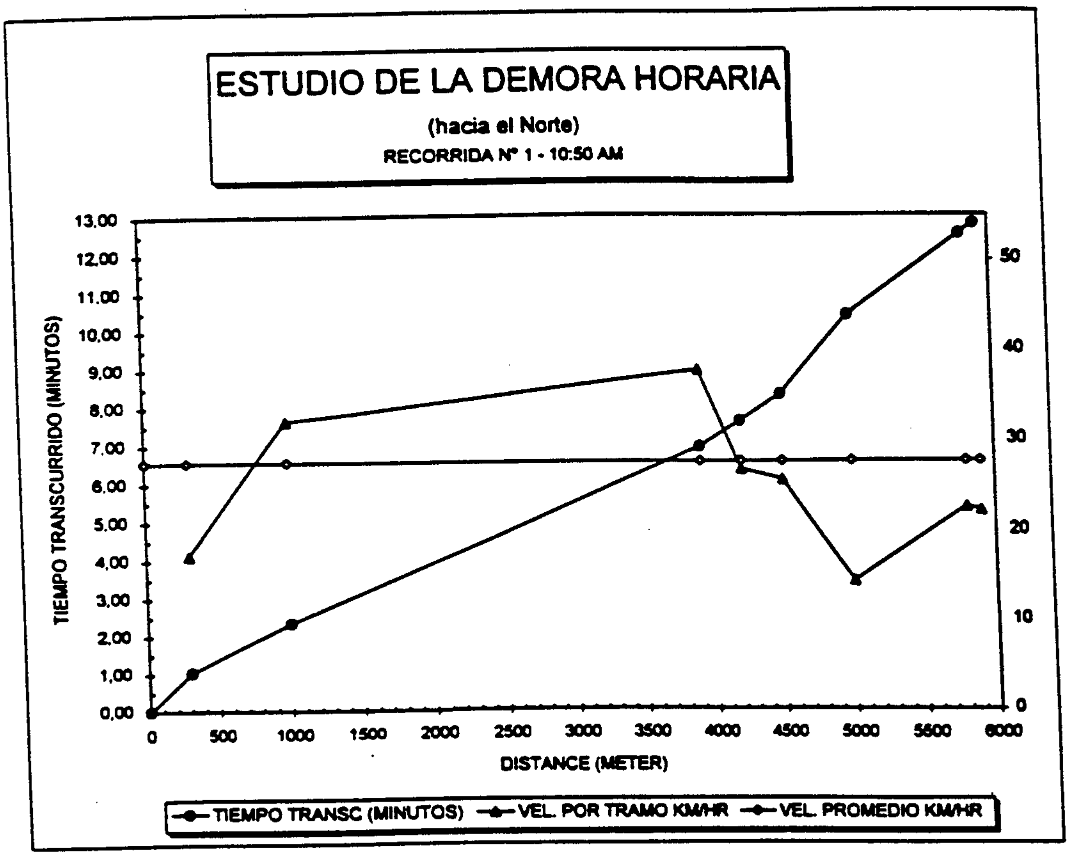
Based on field investigations, the travel time and delay study, and discussions held with UBATEC's traffic experts, the following deficiencies have been identified for Route 202:

- The existing traffic lights and the related computer equipment are in poor condition and shall be replaced.
- Along the whole route, road markings and signs are not appropriate for safe and efficient traffic operation.
- Route 202 is a rural road without medians or well defined passing and no-passing zones.

Route 4 – Ruta Provincial 202 (*Provincial Route 202*)

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Railroad Bridge	0	0.00		27.72
2	Av. Avellaneda	300	1.03	17.48	27.72
3	School Signal	1000	2.33	32.31	27.72
4	Suipacha	3900	6.93	37.83	27.72
5	Av. Intendente Arnoldi	4200	7.60	26.87	27.72
6	Santa María de Oro	4500	8.30	25.71	27.72
7	Sobremonte	5000	10.38	14.42	27.72
8	Constitución	5800	12.50	22.64	27.72
9	Juan D. Perón	5900	12.77	22.22	27.72
AVERAGE SPEED IN THE AVENUE: 27.72					

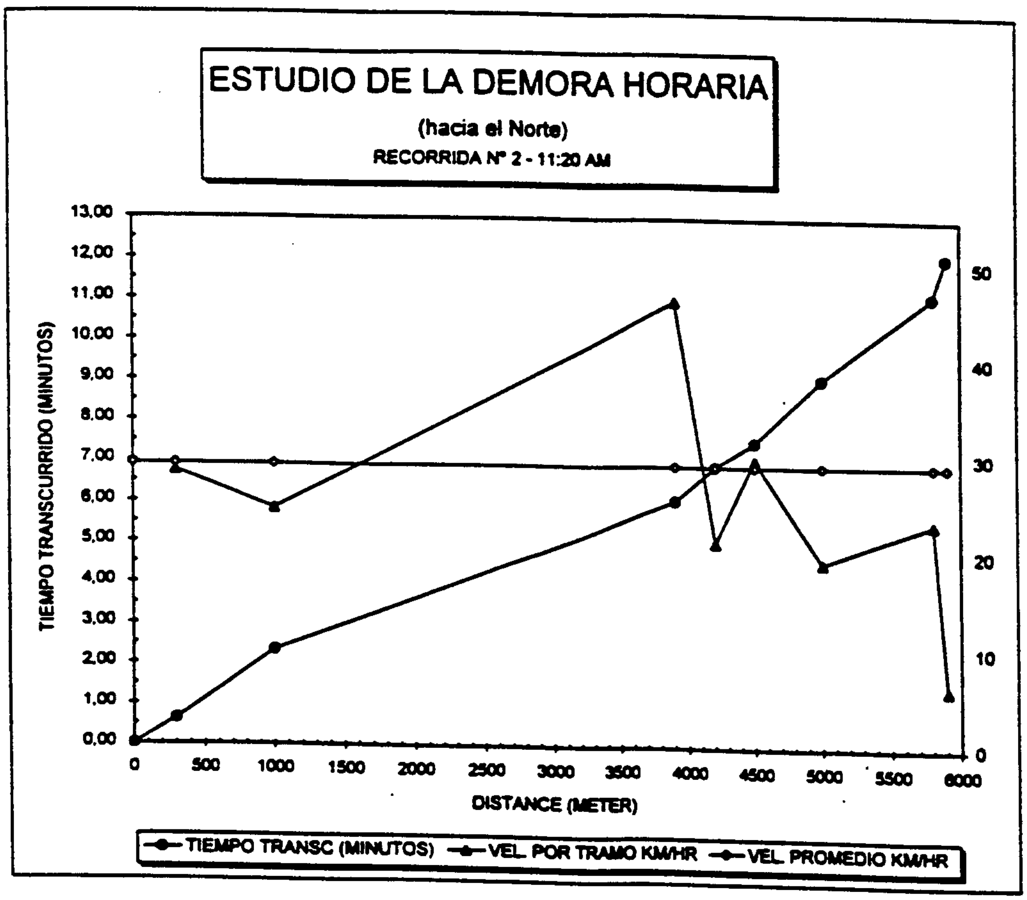
Figure 8 A – Ruta Provincial 202. – Study of the Traffic Delay



Route 4 – Ruta Provincial 202 (*Provincial Route 202*)

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
1	Railroad Bridge	0	0.00		29.30
2	Av. Avellaneda	300	0.63	28.57	29.30
3	School Signal	1000	2.33	24.71	29.30
4	Suipacha	3900	6.08	46.40	29.30
5	Av. Intendente Arnoldi	4200	6.92	21.43	29.30
6	Santa María de Oro	4500	7.52	30.00	29.30
7	Sobremonte	5000	9.07	19.35	29.30
8	Constitución	5800	11.12	23.41	29.30
9		5900	12.08	6.25	29.30
AVERAGE SPEED IN THE AVENUE: 29.30					

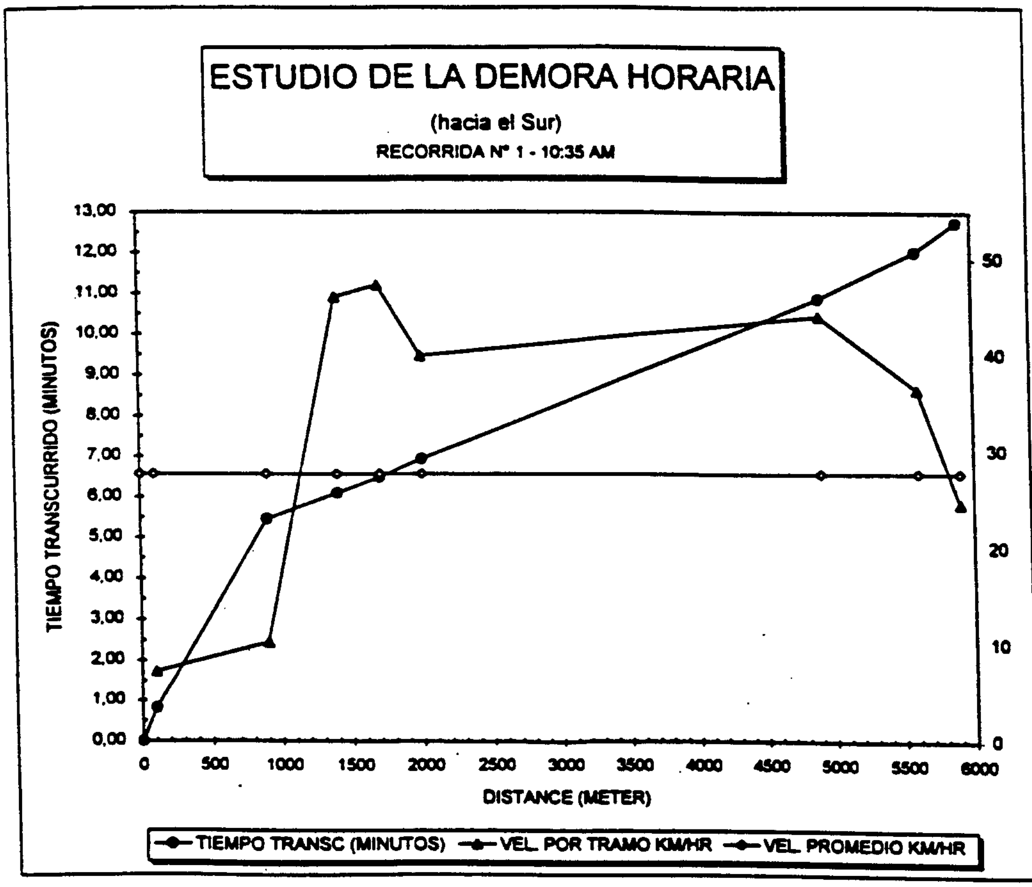
Figure 8 B – Ruta Provincial 202. – Study of the Traffic Delay



Route 4 – Ruta Provincial 202 (*Provincial Route 202*)

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
9	Juan D. Perón	0	0.00		27.76
8	Constitución	100	0.82	7.32	27.76
7	Sobremonte	900	5.45	10.37	27.76
6	Santa María de Oro	1400	6.10	46.15	27.76
5	Av. Intendente Arnoldi	1700	6.48	47.37	27.76
4	Suipacha	200	6.93	40.00	27.76
3	School Signal	4900	10.87	44.16	27.76
2	Av. Avellaneda	5600	12.02	36.52	27.76
1	Railroad Bridge	5900	12.75	24.66	27.76
AVERAGE SPEED IN THE AVENUE: 27.76					

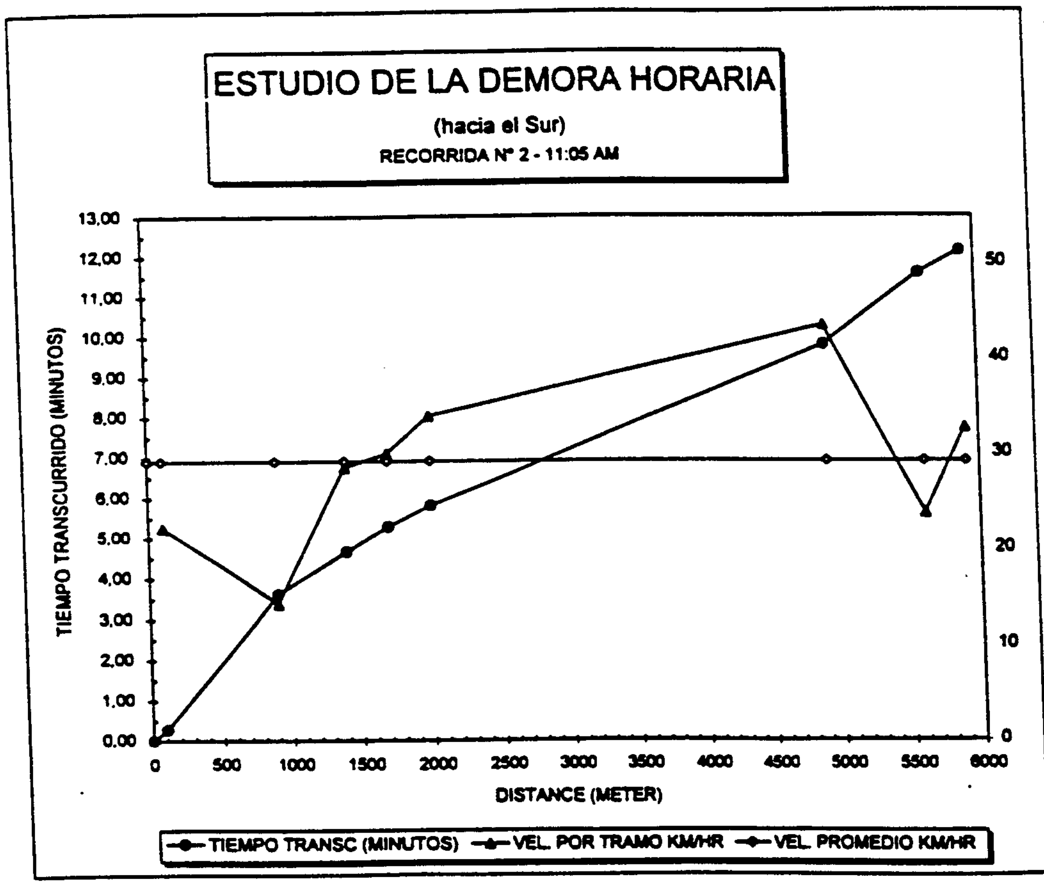
Figure 8 C – Ruta Provincial 202. – Study of the Traffic Delay



Route 4 – Ruta Provincial 202 (*Provincial Route 202*)

SECTION	CROSSING	DISTANCE (meters)	TIME (minutes)	SPEED BY SECTION	AVERAGE SPEED
9	Juan D. Perón	0	0.00		29.21
8	Constitución	100	0.27	22.22	29.21
7	Sobremonte	900	3.62	14.33	29.21
6	Santa Maria de Oro	1400	4.67	28.57	29.21
5	Av. Intendente Arnoldi	1700	5.27	30.00	29.21
4	Suipacha	200	5.80	33.96	29.21
3	School Signal	4900	9.80	43.50	29.21
2	Av. Avellaneda	5600	11.57	23.73	29.21
1	Railroad Bridge	5900	12.12	32.73	29.21
AVERAGE SPEED IN THE AVENUE: 29.21					

Figure 8 D – Ruta Provincial 202. – Study of the Traffic Delay



3. RECOMMENDATIONS

3.1. *Solutions for the operations and Traffic Safety*

It has been developed a set of traffic recommendations that have as basis engineering aspects for each one of the deficiencies identified for each one of the selected routes. These deficiencies for the four (4) selected routes have been described in Chapter 2- Report Existing Condition. As it was mentioned above, in front of the unavailability of traffic data including accidents statistics and information on the traffic volumes in specific places, the identification of the existing deficiencies is more or less qualitative in its kind and the proposed recommendations are guided to ease the deficiencies in the whole run of the route and not to improve the traffic operations in an specific place. The proposed recommendations to improve the traffic operations in each one of the four (4) routes are the following:

3.1.1. Route 1: 9 de Julio Avenue

In order to reduce to the minimum the impact of the intersections with the semaphore, with few distance between them, located along of 9 de Julio Avenue fact that produces the forming of vehicles rows in the adjacent intersections, it is recommended to close to traffic some of the minor cross streets during the rush hours of the urban traffic. The course of the existing intersections in 9 de Julio Ave. shows that there exists an important cross street called Avenue each three (3) or four (4) cross streets. For example, between de Mayo Ave and Belgrano Ave, there are three cross streets, Hipólito Yrigoyen, Adolfo Alsina and Moreno; Hipólito Yrigoyen and Adolfo Alsina have a sole sense of circulation in east direction. Anyone of these streets can be chosen to be closed (if can be feasible) in the rush hour and the traffic in south direction can be deviated to another street. In the same way, in north direction, Lavalle or Tucumán (adjacent cross streets between Córdoba Ave. and Corrientes Ave, with a sole sense of circulation in west direction can be closed. Nevertheless, the closing of any of the streets shall demand a more detailed and wide study on the traffic circulation.

It is produced a degree of important traffic bottle neck near the Obelisco, where eight (8) access lanes along 9 de Julio Ave. and three (3) lanes along the lateral street are merged in a total of nine (9) lanes that cross Corrientes Ave. The problem gets worse even more by the convergençe of the buses traffic of the lateral street with the general traffic. It must be analyzed the deviation of the existing bus traffic in the nearness of Corrientes Ave. towards the adjacent north-south street that runs parallel to 9 de Julio Ave.

The pedestrians along 9 de Julio Ave. cross simultaneously with the green phase of the cross streets. The green minimum times for the cross streets are very high due to the quantity of lanes that the pedestrians shall cross along 9 de Julio Ave. This situation gets worst between Córdoba Ave and Belgrano Ave., where the raised island of the divisory central band is replaced by a painted island, eliminating in this way the shelter area for pedestrians. In order to provide more green times for the traffic that circulates by 9 de Julio Ave., it shall be analyze the provision of a shelter area for pedestrians in the existing painted area of the central divisory band between Córdaoba Ave. and Belgrano Ave, and besides to provide the medium in order the pedestrians can cross 9 de Julio Ave. in two stages.

To replace the existing predetermined time of traffic lights with a signals system that offer more answers to the traffic and to develop time plans that are compatible with the traffic variations.

3.1.2. Route 2: Pueyrredón Avenue

To consider the closing of some minor streets during the rush hours of traffic in order to minimize the impact of the signalized intersections with few distance between them as well as it was been analyzed for the previous route.

The analysis of the trip time and delay study indicate that there are two models of different trips: one to the north of Corrientes Ave. (practically without delay or vehicles rows formation), and another to the south of same avenue with important delays. This problem can be reduced up to such extent, controlling the traffic arrival volume that operates over Pueyrredón Ave. and goes to Corrientes Ave. It shall be designed a well-balanced advance for the traffic with south direction between Las Heras Ave and Lavalle street, in order that the traffic with south direction that approximates to Corrientes Ave. does it in a vehicles small platoon instead of a large vehicles platoons as it is the existing situation and that cannot be evacuated effectively at the south of Corrientes Ave.

To replace the existing signals system with predetermined time by a signals system that offers more answers to the traffic and to develop time plans that provide a well-balanced advance of the transit to the north and south of Corrientes Ave.

To provide a more efficient marking out in pavement and a signals system for the lane of buses exclusive use in all the extension of the route.

3.1.3. Route 3: Pavón Avenue/Yrigoyen Avenue

To reduce to the minimum the impact of the signalized intersections with few distance between them, in the two ends of the project, making that two adjacent intersections at short distance one from the other were under a traffic signal controller.

In the existing situations, the signals advance is deficient as well in the north direction as in the south direction. To replace the existing signals system with predetermined times by a signals system that offer more answers to traffic and to develop well-balanced time plans in basis to the existing traffic model and to the divisions in directions.

To provide a more efficient marking out in pavement and signals system for a more efficient operation of the traffic in the whole route.

3.1.4. Route 4: Provincial Route 202

To replace the obsolete signals system with predetermined times by an automatic or semiautomatic signal system.

To consider the coordination provision between the signals systems between Suipacha and Juan D. Perón Ave.

To provide pavement marking out and signals for the crossing and non crossing areas.

To provide curbs and paved shoulders in the south end of the project.

3.2. *Solutions with the application of Intelligent Transportation Systems (ITS)*

As result of the evaluation of the needs and of the definition of the problems presented in the routes comprised by the study, there have been identified opportunities for the application of the ITS (Intelligent Transportation System = ITS) that could potentially solve some of the problems. The opportunities identified for the ITS application in this initial stage, are more wider in this functional description from a conceptual point of view. Some of the important opportunities for the ITS application that presently exist within the routes in study, are based in discussions held with the UBATEC traffic experts.

Several ITS centers in all the world and many of them within the United States, have been operating during several years. From these systems there have been learnt some useful lessons, regarding to which are the technologies which are more efficient to satisfy the needs of the region and have more possibility of success. In base to this experience, are formulated the following suggestions that could have big possibility of success and at the same time to satisfy the transportation needs of the region. The opportunities for the application of the following ITS, are compatible with the Intelligent Transportation Infrastructure (ITI).

3.2.1. Functional Descriptions of the Subsystems

<u>**Traffic Control Advanced Systems**</u>

The routes included in this Phase 2 of the study, comprised signalized intersections with few separation distance one from the other. Nevertheless, these signals are all independent and does not function in coordination one with the other. Besides, all of them have predetermined times according with the transitory variations of the traffic demand during the course of a typical day. The traffic control advanced systems have shown their efficiency in several cities of the whole world. Not only placing the different signals distributed under a same frame, but also giving a quick available technology for the surveillance of the wide system of main roads, collector streets and local roads. Besides, this type of traffic control system should also allow the management of the freeway and of the main roads, making in this way a more efficient use of the existing infrastructure.

A particular way of the Traffic Control Advanced System is the Closed-Loop Traffic Signals System. These kind of systems are essentially systems that have as a base the main roads and allow the traffic coordinated operations with the capacity to modify the time plans by one hour of the day or in response to the variable demand of traffic. These systems are called "closed-loop" because they closed the information loop that does not exist previously. Beforehand to them, the traffic signal systems could modify the time plans by hour of the day. Now, the "closed-loop systems" not only can modify their time plans, but also can monitor the effect of the changes made in the time plans over the traffic operations and therefore, to continue making the necessary changes in the time plans in order to reach an optimum flow of traffic.

The components of a closed-loop traffic system comprised a master controller, several local controllers, an interconnection system, sampling detection system and a working post with computer. Next there are detailed the descriptions of each one of these components:

Master Controller: The master controller keeps the signal time plans and selects the more appropriate time plans in base to the information he receives from the sampling detectors system. The master controller is pre-programmed with several time plans. Each plan is associated with certain thresholds of traffic volume/occupation level in the different sampling detectors. When the thresholds are reached, the pertinent time plans are selected and they are instrumented in the different local controllers. Master controllers are different according to manufacturers. Besides, great part of them can manipulate several subsystems and each subsystem has several individual intersections.

Local Controllers: This controller is installed in each signalized intersection. It is responsible of the start up of the time plans determined by the master controller. The local controller is connected to the detectors in each one of the accesses to the intersection. These detectors monitorized the presence of traffic and allow to the local controller to synchronize better all the time plans in basis to more localized conditions.

Interconnection System: This is the vertebral communication system in a closed-loop system. This system connects the master controller to each one of the local controllers. The system can be wired or wireless. The wire options include copper twisted pair cables or of optics fiber. The wireless options include narrow band radio frequency or extended spectrum radio.

Sampling Detectors System: These are typical inductive loop detectors of 2 m. by 2m., installed in different critical points in all the extension of the main road. These devices measure the traffic volume and the speeds and provide this information to the master controller.

Working Post with PC: Each closed-loop system comes with a software that can be installed in a PC of a working post, in a remote Traffic

Operation Center. The software allows the operator to program the master and the local controllers, to perform maintenance verifications as well as to produce reports of the closed-loops operation system. The communication between the working post with PC and the master controller installed in the main road is by means of telephonic modems.

Public Transportation Advanced Systems (PTAS)

During many years, the discussions of the transportation planners were centralized in the passengers massive transportation as an instrument to manage the demand in our congested roads. And the suburban passengers have adopted the use of cars even in great number. The main reason for which the passengers public transportation has not much success, is that the people feels it as a less reliable medium than the car. The users of the passengers massive transportation system are never sure if a bus shall appear or if it shall arrive on time. With the ITS and the reasonable use of technologies that are under the master system of the PTAS, the passenger massive transportation could be an important alternative to the use of car; its success shall depend of a main aspect: the PTAS provides a high grade of reliability that need the users of the passengers public transportation with the security of the arrival and departure time. Besides, the PTAS provides the tool in order that the suppliers of the passengers public transportation maximize the use of their inventories.

The main components of a PTAS include: a global positioning system, automatic collection of fares and passengers'counters, priority of the public transportation and a working station in the Traffic Operation Centers. Next there is a description of each one of these components.

Global Positioning System: The most important aspect of the PTAS is the capacity to follow the movement of the different vehicles of the public transportation system that operate in the real time network. Generally, this follow-up is made using receivers of the Global Positioning System (GPS) which is installed on board of the vehicles. The GPS receivers obtain the information on the location through the GPS satellites launched by the United States Defense Department. This information is transmitted to the Working Station located in a Traffic Operation Center. The communication mean is generally wireless and used dedicated radio frequencies.

Automatic Collection of Fares or Passengers'Counters: This device is also installed on board of the vehicles of the passengers public transportation system. The system can be an automatic collection of fares system in which the passengers use debit electronic cards, similar to a toll collection electronic system. This system also makes the follow-up of the quantity of passengers who go up to the public transportation vehicle. Besides, some PTAS have passengers automatic counters that make the follow-up of the counting of passengers that go up and go down of the vehicles of the public transportation system.

Working Station: All the PTAS come with a software that visually represents the location in the screen of the different vehicles of the public transportation fleet, as well as their load of passengers. In basis to the location, the software of the working station, takes into account the arrival esteemed time in all the following stops. This information can be then visually represented in the different stops of the passengers public transportation. The software also allows the evaluation of the different routes of the passengers public transportation to verify if the times between vehicles, or the routes, or the schedule shall be modified in order to optimize the use of vehicles.

Priority of the Passengers Public Transportation: It is without any doubt the most common component of the PTAS. The same allows the public transportation vehicles, to pass through traffic signals without stopping giving priority to the green phase. With this component, the trip times or the public transportation vehicles are greatly reduced because they do not have to stop by the red phase in the different traffic lights. The priority is reached by means of a signal sent from the public transportation vehicle to the traffic signal located downstream. If that traffic signal is showing green for the access in which the public transportation vehicle is located, so that green phase is kept up to the moment the public transportation vehicle crosses the intersection. If the signal is showing red, so it continues with the normal phases and turns green for the access with the public transportation vehicle. This system has been used for emergency priority by the police or medical emergency vehicles.

3.2.2. System Instrumentation Issues

Traffic Signals Advanced Systems

Presently, all the traffic signals in the area of Great Buenos Aires are signal systems with predetermined times. But only a few intersections are coordinated.. Nevertheless, these are day hour plans which are obsolete. So, the instrumentation of a traffic signals advanced system, specially a main road system of closed-loop, shall be enough extensive. The more practical method should be its starting up by stages.

Stage 1: The first step should be to improve all the traffic signals within a traffic signals proposed system to a fully automatic compatible system of closed-loops. This implies the installation of a detection system inside each access to the intersection and a new fully automatic local controller of 8 phases.

Stage 2: The next step should be to define the traffic signal subsystems or groups. An empirical standard is to place all the intersections signalized with few distance one of the other in a particular main road under a subsystem or group. In the moment to define the subsystem, it should be recognized that the closed-loop main road systems function better when the bigger part of traffic is of long distance. If the intersections which are inside a subsystem have a high volume of traffic that turns round, then there shall be compromised the quality of the traffic advance. Once the subsystem have been defined, an intersection is chosen as master location. In such intersection a master controller is provided, besides of all the normal equipment related with traffic local control in the intersection.

Stage 3: In this final stage, it should be start up the interconnection system. As the intersections have between them an space of only 100 to 300 mt, the better solution in cost function should be the interconnection system of extensive spectrum. The extensive spectrum equipment shall be installed in the master controller and in each one of the local ones. In this stage, it should be also installed the working station with PC in an adequate Traffic Operation Center and it should be established the telephone communication linking between the PC and master controller installed in the place for each subsystem.

The operation of a traffic control advanced system by part of a private concessionaire is a practical fact only if there is a Traffic Rules Fulfillment System (TRFS). The analysis of the urban Violation Enforcement System (VES) is studied in another section.

Public Transportation Advanced System (PTAS)

The PTAS operation also needs a careful planification and an installation in stages. It shall be necessary to improve the existing vehicles with new equipment. When operating this system, the PTAS should be provided in those routes that have the higher volumes of passengers. The starting up in stages is yet necessary for those routes with high volume of passengers as it is analyzed farther on.

Stage 1: The first step to start up a PTAS is to determine the more appropriate communication method from each public transportation vehicle to the Working Post in a Traffic Operation Center and from this center to the public transportation vehicles and to the stops for the public transportation vehicles. The most effective solution from the cost point of view is the dedicated narrow band radio. Nevertheless, there shall be researched another options such as microwave and cellular. This research shall be made as a separate study.

Stage 2: Once the communicated system is determined, the next step should be to recondition the public transportation vehicles with positioning devices (such as the GPS), an electrical system to collect the fare and the priority transmitting system of passengers public transportation. At the same time, there shall be installed priority receivers in all the signalized intersections along the passengers public transportation route.

Stage 3: The final stage should be the installation of the Traffic Operations Center and the communication links with the public transportation different vehicles and the stops of such system. In the public transportation stops, there can be installed posters with messages indicating the arrival hours and all changes in the time table. In the main center of the passengers public transportation, there can be installed information windows to give information on the public transportation besides of all kind of information for the passenger.

The start up of PTAS by a private concessionaire is relatively easier than that of a traffic control advanced system. The PTAS can be financed through increases in the fares collection that can be justified with the improvement in the service provided by the PTAS. Besides, the private concessionaire can generate additional earnings through the sale of advertisement spaces, in the public transportation vehicles or in the public transportation stops or in the information windows.

3.2.3. Operation and Maintenance Strategies

The traffic control advanced system as well as the PTAS, comprises several operation and maintenance issues. Both systems must cross limits of political division and jurisdiction. For example, a main roads system could cross provincial limits. Different concessionaires could operate different PTAS. Even though each concessionaire shall be responsible of his own system, and also a master organization should exist to coordinate the operation and maintenance activities between the different concessionaires. The traffic and passengers public transportation information, shall be available in a central office to establish if it necessary to make some changes in the whole system that benefits all the region in its whole and not only to an individual subsystem. This aspect can be achieved by means of granting the provision of a Passenger Information Advanced System (PIAS). The PIAS supplier shall be responsible to gather all the information coming from all the different concessionaires in only one point and distribute it to the different concessionaires or to the public in general. There can be generated earnings collecting the information that it is distributed.

Each one of these Transportation Information Systems (TIS) shall be monitored in a constant and synchronized way in order to improve its operative efficiency. An advanced system of traffic control shall be inspected each six months and also shall be performed modifications in the time plans that sooner respond to the changes produced in the trips demand since the original time plans were prepared. The information about passengers on board coming from a PTAS shall be periodically verified in order to determine which are the most income-producing routes, if any public transportation stop shall be relocated to reach the maximum number of passengers on board, if the public transportation schedules shall be adjusted in order to satisfy better the passengers'needs.

3.2.4. Installation and Operation Typical Costs

The installation and operation typical costs are the following:

TIS SYSTEM	INSTALLATION	OPERATIONS
Traffic Control Advanced System (Assumes 10 intersections in the subsystem)	$ 500.000	$ 70.000/year
Public Transportation Advanced System (For 1 route with 10 stops and 4 buses in the subsystem)	$ 250.000	$100.000/year

3.3. *Traffic Laws Enforcement System*

3.3.1. Functional Characteristics

Next, there are described the functional characteristics of the Traffic Laws Enforcement Video System (TLFS) that could be installed in a urban/suburban main road within the Great Buenos Aires.

The TLFS is formed by two components: a device that measures the vehicle speed and a digital system the captures the image (image capture device). Generally, these systems come in an integrated package in which both components and the necessary software to operate the unit, are supplied by the manufacturers. In the cases in which it should be already installed in the place the vehicle speed measuring device (surveillance equipment such as the loop detectors used for the signals control); there shall be installed an interface with the component that captures the image of the TLFS.

The TLFS could be used for automatically detection and provide the measured data for each vehicle in particular and the corresponding digitalized images of static video, of a vehicle that crosses with red light and/or violates the speed regulations stipulated for the intersections. If the appropiate surveillance equipment is installed, the TLFS could also be used to detect the infringements to the restricted use of lanes and obstruction to the pedestrians crossing. In case of no-obstruction, these systems are generally able to provide images for the recognition of the number of the license plate (by the operators or by a reader equipment of license plates) with a 95% accuracy in normal conditions (by day or by night) and with approximately a 90% of accuracy under adverse climatic conditions (fog, rain).

Besides of the images captured, the system generally supplies the following information for each traffic infringement:

- Duration of the last yellow phase;
- Period of red phase;
- Statistical charts per infraction;
- Number of infraction;
- Identification of the place;
- Photograph interval; and
- Speed of vehicle

Next, there are detailed the parameters that are generally comprised in these kind of systems:

- **Period in red phase**: is the time since the beginning of the red light cycle after which it is considered that a vehicle is in infraction; generally from 0 to 5 sec. with intervals of 0,1 sec.

- **Green/yellow speed register**: is the minimum speed to which a speed infraction is registered; generally around the 20 to 150 km/h.

- **Quantity of statistical charts per infraction**: usually established in two and a maximum of four.

<u>**Mechanical/Environmental Characteristics**</u>

The standard characteristics for this type of equipment are the following:

- **Compartment Protection**: resistant to vandals.
- **Operation/Access**: a person from the street level.
- **Operation temperatures**: from -10 up to 60°C. 80% HR over the 20°C and to have a temperature sensor that disconnects the unit under extreme conditions.
- **Voltage**: 100 -250 V a.c.

Data Local Storage

These systems are generally equipped with removable hard discs or optical discs and digital audio bands to file data. The storage local capacity is of approximately 30.000 statistical charts (around 30.000 infractions in one chart). Each unit is able to provide data function to produce statistical reports about infractions information. For example: all the infractions by crossing with red semaphore with a period in red higher than 10 sec. corresponding to the previous week.

Data Recovering and Remote Calibration

The manufacturers of these systems generally supply the software for the central control which is able to establish the communication by modem, with each one of the TLFS units installed. The software allows the recovering of the infractions information, including the images. By the other part, this software makes possible the configuration and calibration of each TLFS units in a remote way.

Recognition of the Number of the License Plate

Once the TLFS images are recovered, it is necessary to identify the number of the license plate in the image of the infraction. This can be made manually by an operator through the visual inspection of the image. Also there are products of the License Plate Reader (LPR) type (generally supplied by the same TLFS manufacturer) that could perform such task automatically. The LPR applies algorithm of characters recognition to identify the number of the license plate from the infraction image and inserts it in the infraction information, confirmed by an operator.

3.3.2. Operation and Installation Issues

Placement of the Camera

Differently from the video standard systems for vehicles detection (detection only of the vehicle's presence), in which the image resolution of an individual vehicle, is not essential, the TLFS cameras shall be installed in such a way that it can be identified in the image the number of the license plate. In toll systems application, for example, the cameras are placed at the sufficient low height (to the reach of a person) to guarantee that the objective is reached.

Nevertheless, the direction of the intersections in a city presents challenges that require that the equipment be installed to a greater height. The problems generally presented in the intersections are the following:

- **Obstruction of the image**: can be by big vehicles, pedestrians or another structures such as newspaper stands, etc.
- **Close together vehicles**: vehicles which are very close behind the vehicle that makes the infraction, could obstruct the view of the license plate. The installation of cameras with a wider angle from the horizontal plane, shall reduce the number of obstructed images.
- **Vandalism**: unlike from the environment in which is developed the toll system, in which there are generally safety guards and operators of the toll system in the nearness of the equipment, the cameras placed in the intersections shall not have protection most part of the time. The installation at greater heights made to be less possible to occur vandalism acts regarding the equipment.

Nevertheless, it is important, to find an installation height in which the image quality was not compromised.

<u>**Multilanes**</u>

Avenues such as 9 de Julio Avenue have up to seven lanes by circulation sense. Generally, the TLFS equipment has the capacity to comprise up to three lanes with only one camera. In the case of Buenos Aires it shall be necessary to install additional cameras (or equipment) for the covering of the multilanes. Besides, according with the geometry of the roadway, there could be required bent structures over some of the wider main roads (multilane) with signals in order to install the camera equipment.

<u>**Legal Requirements**</u>

The rules or regulations in force to support the procedures of the laws fulfillment by automatic systems, have a direct impact on the installation place and the kind of equipment to be used. For example, if color photos are required, it is necessary to have a flash unit that lightens to make visible the TLFS under reduced light conditions. By the other part, if the images with gray scale are sufficient, it should be possible to install a stroboscopic spectrum non visible for the light.

Also, it could be a legal requirement, that must be a proof, to show the red light in the signal together with the image of the vehicle that commits the infraction with red light. If this were the case, the TLFS cameras shall be installed in such a way that all this were shown in the photo of the infraction.

Existing Conditions

Another issues that must be taken into account for the TLFS installation, is the present condition of the signals system. The characteristics to be considered are the following:

- **Cabinets for Transit Control**: it is important to evaluate if the cabinets of the existing controllers have enough place to support the requirements of the system equipment that shall be installed in the TLFS ground. It is also necessary to evaluate the additional requirements of ducts to support the TLFS and its possible interface with the existing traffic control equipment.

- **Communication Infrastructure**: an important aspect of the operations of the TLFS equipment is the availability of lines (telephone or another type) for the communication with the central to load or unload information. For each location, it shall be made an evaluation of the availability of communications and of the necessary infrastructure to support it.

- **Signals System**: as it was previously mentioned, it could be feasible to use the existing inductive loop detectors and which are installed in some intersections for the control of the signals, to shoot the TLFS images capture device. It should be convenient to evaluate its adaptation and interface cost for each intersection with the new TLFS system.

- **Energy**: for each intersection it should be evaluated if there is adequate available energy or the way in which the same can be supplied.

Operation and installation typical costs

Table 1 shows the standard values of the operation and installation costs.

Table 1: TLFS/LPR Operation and Installation Costs

TFLS System (includes speed measuring equipment)	$ 35.000-$40.000 per lane (plus cameras installation)
Software-Central Control	$ 25.000 for any quantity of installed TFLS
LPR Software	$ 10.000 per seat
Operation (Assumes operation 24 hr. per day)	0,48 KW/hr per day (camera with heater) 0,50 KW/hr per day (processor)
Maintenance	5% of the capital cost per year

APPENDIX

DEFINITION OF THE PRIMARY NETWORK OF THE METROPOLITAN AREA

1. INTRODUCTION

In the present advance report regarding phase 2 of the Traffic Management Study in Buenos Aires, there is a first section with the general description of the urban structure of the Metropolitan Area of Buenos Aires and the frame of the Freeways Network in the Area, in a second section with the description of the Primary Highway Network of the Area in study, and finally, a characterization of the highways from the point of view of volume and settlement of the traffic.

Is from this network that there have been selected the specific sections or segments for a more detailed survey.

2. URBAN STRUCTURE

Buenos Aires Metropolitan Area is located around the Federal Capital; together to this city it is consolidated a first ring comprised by two main groups and formed by 24 districts.

While the first main group formed by Avellaneda, Lanús, Lomas de Zamora, La Matanza (in part), Morón, Ituzaingó, Hurlingham, San Fernando, San Isidro, 3 de Febrero y Gral. San Martín. The second main group is formed by Almirante Brown, Berazategui, Esteban Echeverría, Florencio Varela, Merlo, Moreno, Quilmes, Tigre, Malvinas Argentinas, José C. Paz, Ezeiza, San Miguel, and La Matanza (in part).

The Metropolitan Area limits with a second ring formed to the West by Pilar, Gral Rodriguez, y Marcos Paz; to the South with Cañuelas, San Vicente, y La Plata; to the North with Escobar; and to the East with the Río de la Plata.

The bigger gross and net population densities (more than 150 inhab/ha) are distributed within the first main group. There are also located areas with great covering of services infraestructure and community equipment.

The main use of the soil in this first main group is residential completed by services, by sectors is lacalized industrial activity. In fact, it is verified an advanced process of urban consolidation.

In the second main group, the existence of soil rural use indicates few urban consolidation; that is to say, diminish the population services infrastructure and community equipment. This tendency is stressed in the borderline districts.
The highway infrastructure of the Region is formed by the urban network of the Federal Capital and the several urban and rural highways of the Province of

Buenos Aires, of National Jurisdiction as well as Provincial and Municipal; reaching an approximately length of 25.000 km.

If within the Network are considered the higher rank highways of geometrical design and traffic volumes (regionals trips) it can be identified an structure of three circumvallation concentric rings; and four penetration radial highways that form the accesses network to the Federal Capital. It must be pointed out that the main access highways to the Capital were proposed in a plan of the fifties.

The ring-shaped structure is formed by the Gral. Paz Ave. - Southeast Access (National Route A001), Provincial Route 4 (Camino de Cintura), and the Provincial Route 6. The penetration structure is formed by the North Access (National Route 9) and his three branch lines (Branch line Campana: National Route 9; Branch line to Tigre; National Route A003; and the Branch line to Pilar: (National Route 8), the West Access (National Route 7), Ricchieri Freeway (National Route A002) and extention of the future Ezeiza-Cañuelas Freeway (National Route A002), and the Buenos Aires-La Plata Freeway (National Route 1). Besides the North Access and the West Access are linked between by the Buen Ayre Freeway.

With exception of the Provincial Route 4 and the Provincial Route 6 that belong to the primary network, the other highways form the freeways network of Buenos Aires Metropolitan Area.

3. AMBA HIGHWAY NETWORK

3.1. Province of Buenos Aires AREA

Within the limits given by this highways network appear the primary network of Buenos Aires Metropolitan Area (AMBA), that is basically formed of National and Provincial Routes.

It must be pointed out that some of these Provincial Routes were in their moment National Routes, that were transferred in the past when they stop to fulfill their function of national linking. It is interesting to note that even now great part of the population continue identifying them or by their municipal names or as nationals: Rivadavia Avenue (Ex National Route 7, today Provincial Route 7), and the San Martín Avenue (Ex National Route 8, today Provincial Route 7), illustrate in this matter.
Next it is detailed the forming of the primary network, at such effect it has been followed the work named "The Greater Buenos Aires-Survey and Analysis made within the frame of the Comision Nacional Area Metropolitana de Buenos Aires (Buenos Aires Metropolitan Area National Commission), Ministerio del Interior,

1995 (CONAMBA). It is important to point out that the highways denomination have been updated according to the terminology given by the Highways National Direction and the Highways Direction of the Province of Buenos Aires.

AMBA North sector is formed by National Route 202, Provincial Routes (8,9,23,24,195,197,202) and Maipú Avenue. Next it is detailed the run, municipal identification, and the municipal area they run through.

National Route 202 (Alvear (Province)). From Under Level National Route 9 upto the F.C.G.B.M. crossing (Don Torcuato). In the area of Tigre Municipality.

Provincial Route 8 (San Martín Ave. (Capital), Balbin Ave., Illia (Province). From Gral. Paz Ave. upto Pilar. In the area of the San Martín, Tres de Febrero, San Miguel, Hurlingham, José C. Paz, and Pilar Municipalities. Ex National.

Provincial Route195 (Libertador Ave. (Federal Capital and Province)). From Gral. Paz Ave. upto Provincial Route (PR) 202. In the area of Vicente López, San Isidro, and San Fernando Municipalities. Ex-National.

Provincial Route 197 (Yrigoyen Ave.). From PR 195 upto PR 8. In the area of Tigre and Malvinas Argentinas Municipalities. Ex-National.

Provincial Route 202 (Yrigoyen Ave./Alvear). From PR 195 upto National Route (NR) 9 (Don Torcuato) and from F.C.G.B.M crossing (Don Torcuato) upto PR 8. In the area of the San Fernando and Tigre Municipalities. Ex National.

Provincial Route 23 (Mitre Ave., Del Libertador Ave.). From PR 8 upto Moreno. In the areas of Hurlingham and Moreno Municipalities. Extention ex NR 202.

Provincial Route 24. From PR 8 upto PR 6. In the areas of José C. Paz, Moreno and Gral. Rodriguez Municipalities.

Provincial Route 9 (Road Boulogne Sur Mer). From PR 202 upto NR 9 (North Access-Branch Campana). In the areas of the Tigre Municipality. Ex. National

It is understood thal it must be also included the following highways belonging to the Arterial Network in the Preliminary Survey of the Metropolitan Area, SETOP, 1973 (EPTRM), they are:

Maipú Ave.(Cabildo (Federal Capital) Cazón, 11 de Setiembre, Centenario, Santa Fe, and Maipú (Province)). From Gral. Paz Ave. upto Tigre. In the area of Vicente López, San Isidro, San Fernando, and Tigre Municipalities.

In the West sector of the AMBA the Primary Network is formed by the Provincial Routes (7,201) and the pair formed by the Gaona and Rivadavia 2da. Avenues. Next it is detailed the run, municipal identification and municipal area they run through.

Provincial Route 7 (Rivadavia Ave.). From Gral. Paz Ave. upto PR 5 (Luján). In the area of 3 de Febrero, La Matanza, Morón, Hurlinghan, Ituzaingó, Merlo, Moreno, Gral. Rodríguez, and Luján Municipalities.

Provincial Route 201 (Lope de Vega Ave. (Federal) Capital), Mitre and Roca (Province)). From Gral. Paz Ave. upto PR 8. In the area of 3 de Febrero, Hurlingham, Morón, and San Miguel Municipalities.

Gaona Ave./Rivadavia 2da. (Existing link of the missing section of West Access). From Gral. Paz Ave. upto PR 4. In the area of 3 de Febrero, La Matanza, and Morón Municipalities.

In the AMBA South sector the Primary Network is formed by National Routes (3, 205,V205), the Provincial Routes (1,36), the ex National Route 205. Next it is detailed the run, municipal identification, and municipal area they run through.

National Route 3 (Juan B. Alberdi Ave.) (Federal Capital), Juan Manuel de Rosas Ave. (Ex Provincias Unidas (Province). >From Gral. Paz Ave. upto NR 205. In the area of La Matanza, and Cañuelas Municipalities.

National Route 205 (Newbery, Patricios, San Martín, Los Andes (Province)). From NR A002 upto NR 3. In the area of Ezeiza, and Cañuelas Municipality.

National Route V205 (Buenos Aires, Rocha). From PR 4 upto NR 205. In the area of Esteban Echevarría Municipality.

Provincial Route 1 (Camino Centenario Ave.). From La Plata upto Rotonda de Alpargatas. In the area of La Plata, Berazategui, and Florencio Varela Municipalities.

Provincial Route 36 (9 de Julio Freeway (South)- Pueyrredón Bridge (Federal Capital), Mitre, Los Quilmes, and Calchaquí (Province)). From Gral. Paz Ave. upto PR 2. In the areas of Avellaneda, Quilmes, and Florencio Varela Municipalities.

Ex National Route 205 (9 de Julio Ave. -Pueyrredón Bridge (Capital Federal); Hipólito Yrigoyen Ave./Pavo Ave.(Province)). From Riachuelo upto NR V205. In the areas of Lomas de Zamora, and Lanús Municipalities.

It is understood that also must be included the following highways that belong to the Arterial Network in the Prelimary Survey of the Metropolitan Area, 1970, they are:

Remedios de Escalada de San Martín Ave. (Saenz Ave.-Uriburu Bridge-(Federal Capital)). From the Riachuelo upto Ex. National Route 205 (H. Yrigoyen Ave.). In the area of Lanus Municipality.

F. Pienovi Ave. (Vélez Sarfield Ave.- V. de la Plaza Bridge-(Federal Capital); Freire, Bernardino Rivadavia Ave., Galicia Ave. (Province)). From the Riachuelo upto Ex. National Route 205 (Pavo). In the area of Lanus and Avellaneda Municipalities.

Lomas de Zamora Road - La Noria Bridge"Camino Negro" ("Black Road") (A001-Gral. Paz Avenue (Capital); Presidente Juan Domingo Perón Road, Alberto Larroque (Province)). From the Riachuelo upto Ex. National Route 205 (H. Yrigoyen Ave.).

As it was already mentioned above, it is considered as ring to the Provincial Route 4 circumvallating almost in its totality the Buenos Aires Metropolitan Area and the Provincial Route 6 that should be out of the area of this study. Besides it could be considered in the border of the study area to the Provincial Route 25 which basically connects Escobar with Moreno, and the PR 28 that connects Pilar with Gral. Rodriguez.

Furthermore of this Primary Network there can be identified kind of branches that appear from the above mentioned highways such as PR 11 and its prolongation towards Buenos Aires as San Martín Ave.; the PR 14 (Gral. Belgrano Road) that runs from the junction with the Ex National Route 205 (Yrigoyen Ave.) upto La Plata.

Regarding the Secondary Network or Collector the routes can be identified following what was mentioned in the Preliminary Survey of the Metropolitan Area the Avenues Intendente Crovara (Eva Perón Ave. in the Federal Capital) and E. Mosconi (Emilio Castro Ave. in the Federal Capital) that link Gral. Paz Ave. with the Provincial Route 4.

Besides there can be included the Provincial Route 49 that links PR 11 with the National Route V205.

At last, in order to consider the linking of the urban centers and the same described Network there can be observed the figures A-1 taken from the above mentioned work of the CONAMBA; A-2 taken from the EPTRM; and the figure A-3 that shows the network itself.

3.2. *City of Buenos Aires Area*

The highway network of the City of Buenos Aires is classified by Ordinance 33387 of 1977 and published in the Map 6.1.1.2 of the Municipal Digest. In said network are distinguished a Primary Highway Network that forms basically what has been called in the present Freeways Network Study, and a Secondary Highway Network basically consisting of the existing Avenues. Figure A-4 illustrate about the matter.

In order to understand more clearly there have been pointed out in Figure A-2 the routes that link the Federal Capital with the Province of Buenos Aires.

4. VOLUMETRICAL CHARACTERIZATION OF THE PRIMARY NETWORK

In Table A-1 there are observed the TMDA values for the more loaded sections in which are divided the different routes/highways that form the primary network, the commercials percentage, the Pondered Annual Daily Medium Traffic throughout of all the routes in question, and the identification of the more loaded sector. The information source are the TMDA Publishings from the Highways National Direction as well as of the Highways Direction of the Province of Buenos Aires.

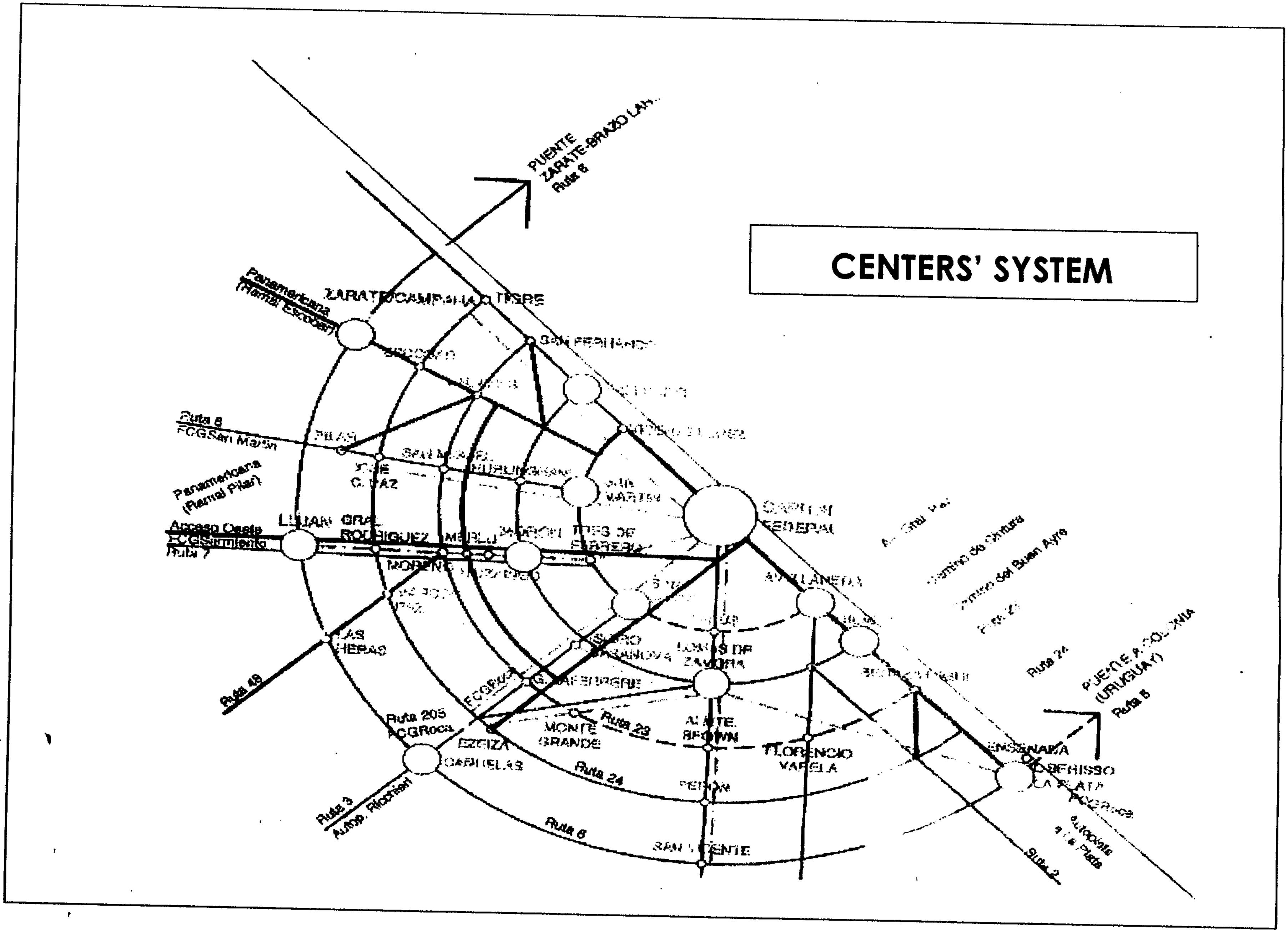
It must be pointed out that by general rule at the same time as it is near the Federal Capital the traffic volumes grow. In consequence when the section is sufficiently long there can be obtained values in the access to the Federal Capital higher to the ones stated; this is in this way each time that the considered section is not sufficiently homogeneous from the traffic point of view.

With exception of the pair formed by the Gaona Ave./Rivadavia 2da Ave. that in the facts is behaving as belonging to the Highways Network can be observed maximums of the order of 55000 vpd (vehicles per day), and a minimum of the order of 7000 vpd (vehicles per day) with a medium value of the order of 34000 vpd (vehicles per day).

Table A1
Volumetrical Characterization of the Primary Network

Road	*TMDA (Highest volume section)*	*% of commercials*	*TMDA Average*	*Highest volume section*	*Source*
Ruta Provincial 8	34216	23	17624	Gral. Paz – RP 4	D.V.B.A.
Ruta Provincial 195	45408	5	30200	Gral. Paz – Olivos	D.V.B.A.
Ruta Provincial 197	18471	35	17573	RP 195 – RP 9	D.V.B.A.
Ruta Provincial 202	22390	20	17308	Don Torcuato – RP 8	D.V.B.A.
Ruta Provincial 23	20468	20	20468	RP 8 – Moreno	D.V.B.A.
Ruta Provincial 24	6600	49	4255	RP 8 – RP 25	D.V.B.A.
Ruta Provincial 9	11421	19	11392	RP 197 – RP 9	D.V.B.A.
Av. Maipú	40000	5	30000	Gral. Paz – Olivos	Record
Ruta Provincial 7	28900	23	13721	Gral. Paz – RP 4	D.V.B.A.
Ruta Provincial 201	30505	23	17800	Gral. Paz – Caseros	D.V.B.A.
Av. Gaona / Rivadavia 2ª	100000	10	70000	Gral. Paz – Ramos Mejía	Record
Ruta Nacional 3	40000	No data	No data	Gral. Paz – RP 4	D.N.V.
Ruta Nacional 205	8300	No data	6000	Ezeiza – RN V205	D.N.V.
Ruta Provincial 1	20905	25	11837	La Plata – Gonet	D.V.B.A.
Ruta Provincial 36	53919	27	11195	Pte. Pueyrredón – Viaducto Sarandí	D.V.B.A.
Ex Ruta Nacional 205	40000	No data	No data	Capital city sorroundings	Record
Ruta Provincial 4	55703	30	40291	RP 21 – RN A002	D.V.B.A.
Ruta Nacional V205	No data	No data	No data	No data	No data

Global Average	33 953



Source: Study prepared by CONAMBA

Figure A-1: Urban Centers Connection

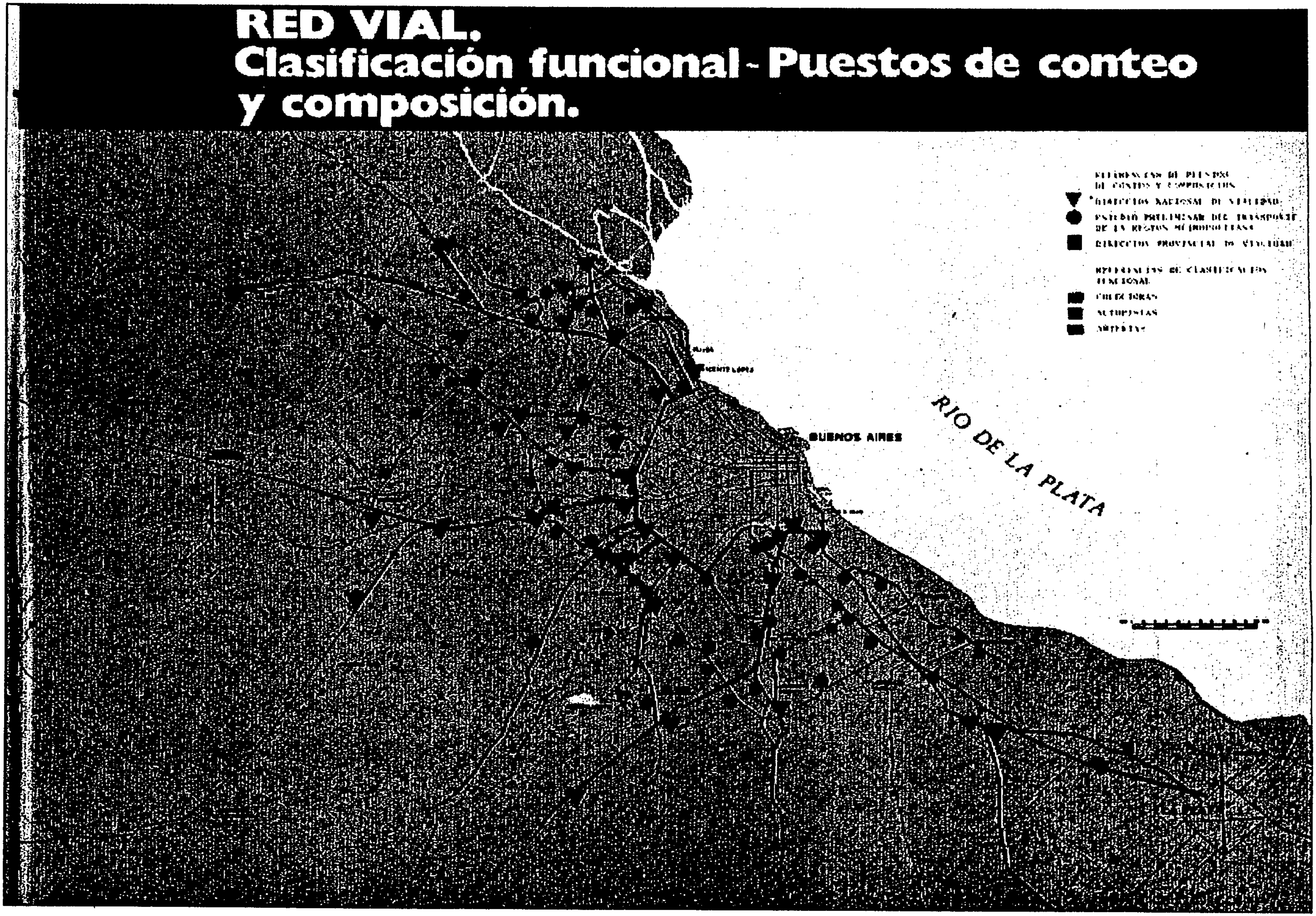


Figure A-2: Roadway Network Classification for the Metropolitan Area

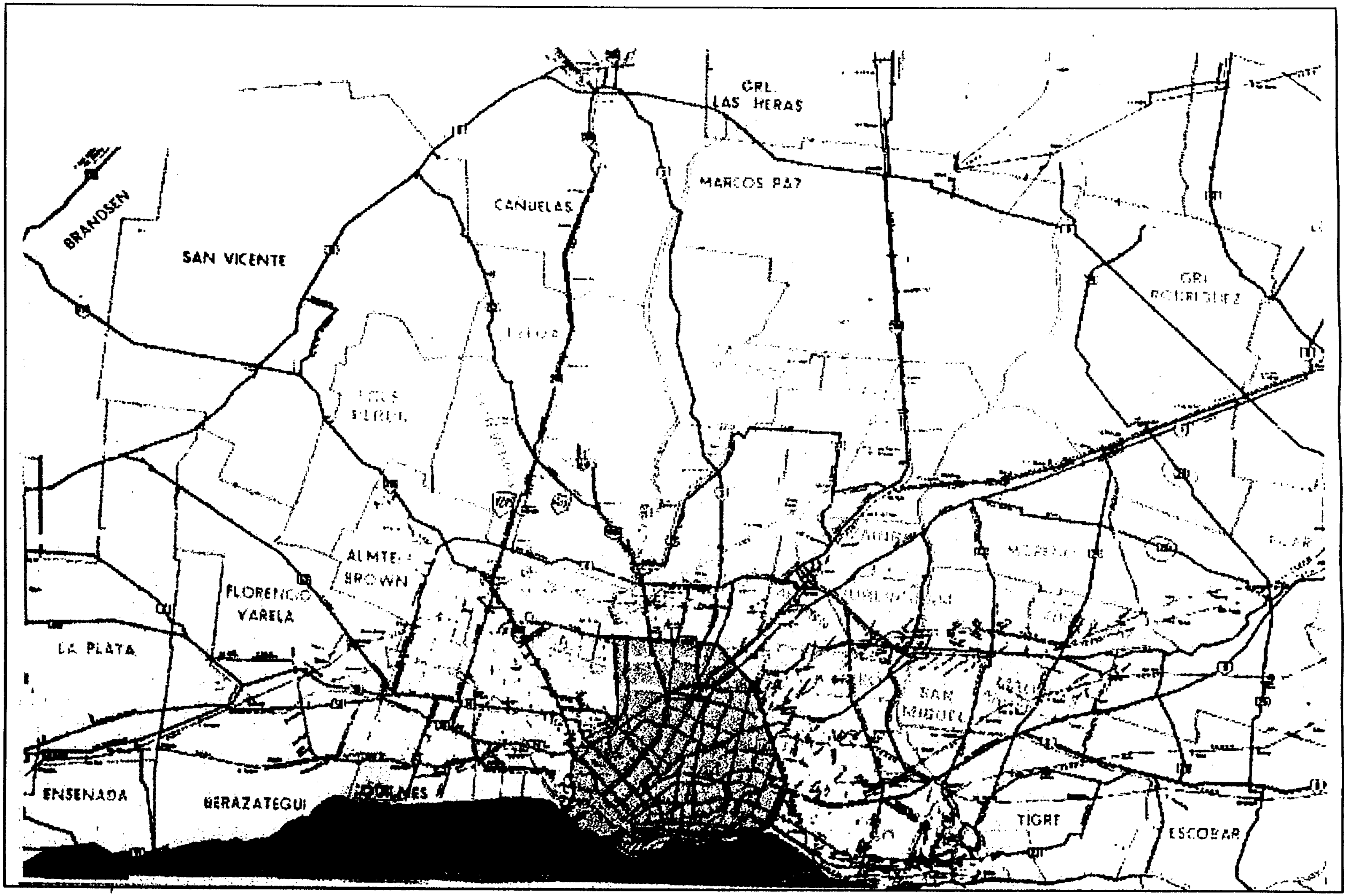
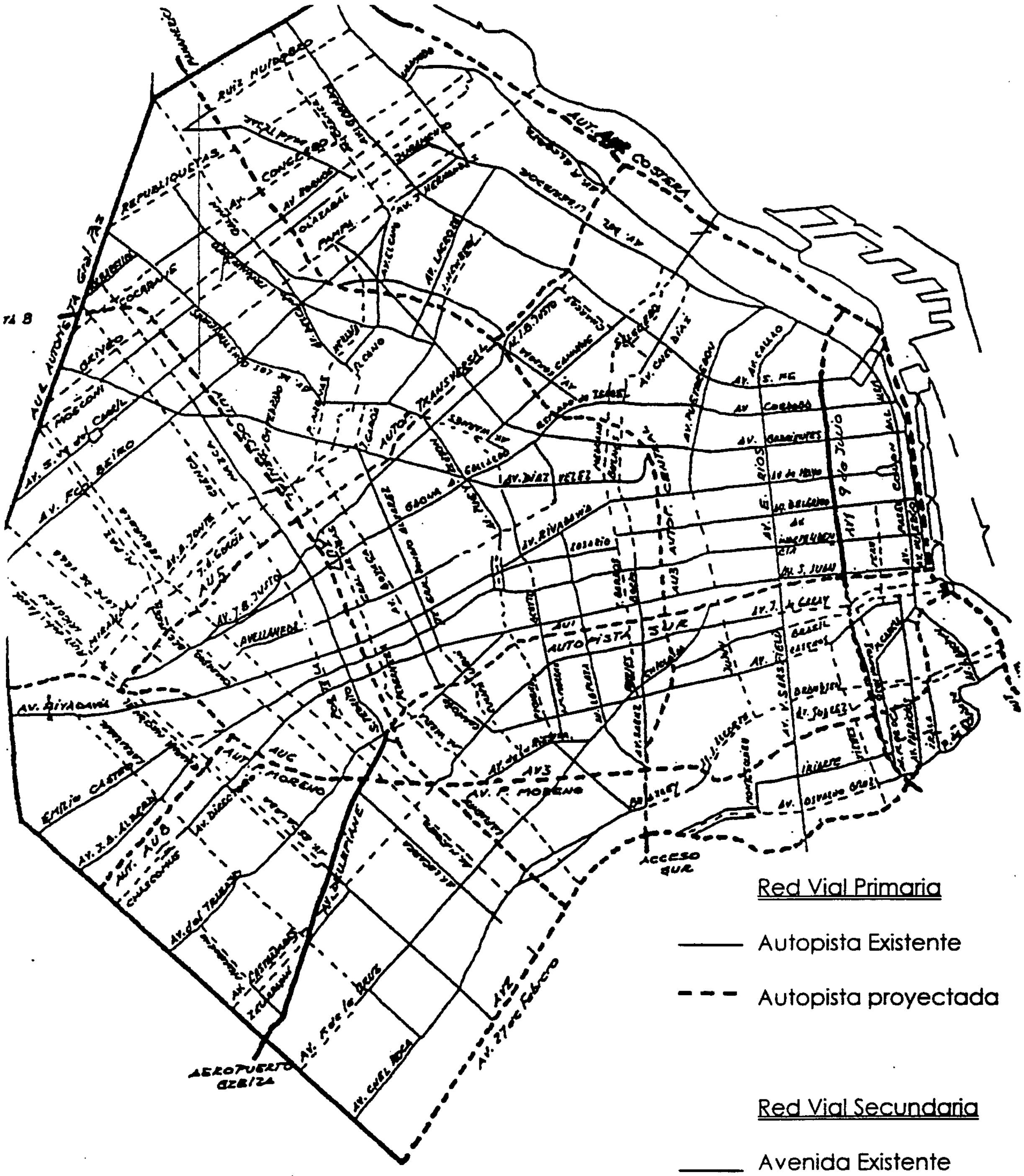


Figure A-3: Roadway Network - Province of Buenos Aires



<u>Red Vial Primaria</u>

—— Autopista Existente

- - - Autopista proyectada

<u>Red Vial Secundaria</u>

—— Avenida Existente

- - - Avenida Proyectada

Apertura de Avenida

Plano N° 6.1.1.2

Ord 33387 - BM 154
(año 1977)

Figure A-4 : Roadway Network – City of Buenos Aires